VOL. XXXV. — No. 3. MARCH 1958.

Monthly

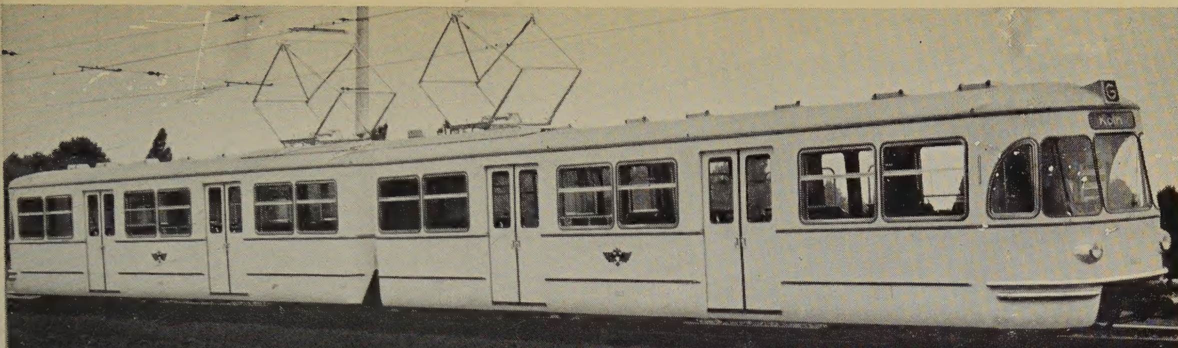
Bulletin

of the International

Railway Congress Association

(English Edition)

Alphabetical Index of Advertisers



Wheel arrangement: Bo' Bo' + 2' 2'
Overall length over couplings: 103' 4"
Motor output: 4×68 kW

Total weight: 42.7 tons
Axle load: 6.1 tons
Max. speed: 37.5 m. p. h.

Each tram has: 45 seats
8 spare folding seats
space for 54 standing passengers

SKF Roller Bearing Axleboxes in modern Tramway Rolling Stock

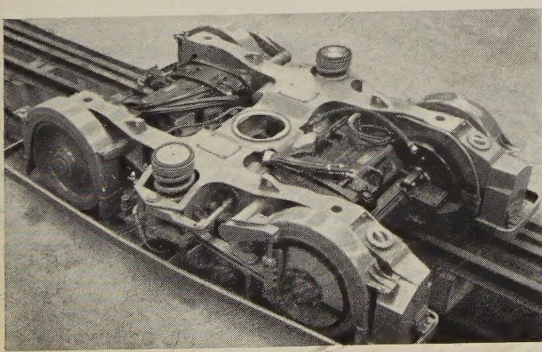
Towns and cities in many countries have recently made considerable additions and modifications to their tramway rolling stock. New features, both in general design and mechanical equipment are being incorporated in the new trams and SKF roller bearing axleboxes, whose great advantages have been proven over the years by experience and hard usage, continue to be widely fitted.

SKF axleboxes offer the following important advantages:

- Smooth, shock-free running — longer life of rails and foundations
- Reduced starting resistance — smoother starting and a saving in power
- Complete reliability — no hot boxes, no bearing repairs — greater availability of rolling stock
- No relubricating between overhauls — simplified lubrication and economy of lubricant
- Grease lubrication — no waste oil to dirty tram chassis and depots — reduced cleaning costs

The illustrations show one of the new twin trams built by West-Waggons, Köln-Deutz, for the Cologne Tramways, and one of the two four-wheel driving bogies. The radial-arm axleboxes are mounted inside the wheels, and each is fitted with two SKF spherical roller bearings.

SKF



Bulletin of the International Railway Congress Association

CONTENTS OF THE NUMBER FOR MARCH 1958.

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OF THE

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(ENGLISH EDITION)

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CONTENTS OF THE NUMBER FOR MARCH 1958.

CONTENTS	Page.

CONTENTS *(continued)*.	Page.
	25

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An edition in French is also published.

Vol. XXXV. — No. 3. March 1958.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[621 .335]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 4.

Comparative study of the periodical maintenance and repair of electric locomotives, in particular as regards :

- **the wear of the tyres (influence of the wheel diameter, the axle-load, the speed, the type of bogies and eventually undulatory wear of the rails, etc.);**
- **the maintenance of traction motors and their transmission (flash at the collectors and methods of coping with it, use of roller bearings for the suspension of the motors and the hollow shafts, etc.);**
- **lubricants used (classical and such new types as bisulphide of molybdenum);**
- **wear of the friction strips of the pantographs.**
- **Kind of work and periodicity.**
- **Organisation of the maintenance and influence of common user (banalisation) of the locomotives.**
- **Prime cost in relation to the type of equipment and the age of the engines.**

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, and the United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by K. J. Cook,

Chief Mechanical and Electrical Engineer, Eastern and North Eastern Regions, British Railways, Doncaster.

I. General data.

System of electrification. — In the English speaking nations there is as yet a relatively small proportion of the railway systems electrified on which electric locomotives are used. The most extensive systems are operated on AC at 15 000 V 16 2/3 cycles and at 11 000 V at 25 cycles sp. There is an experimental section at 20 000 V 50 cycles and subsequent to the year of

	No. of locos.	Axle arrange-ment	Wheel base		Weight in working order - t			
			Overall	Bogie	Mech. parts	Elec. parts	Total	Drvg. a load
A	172	Bo + Bo	30′ 11″	9′ 3″			54	17.2
	40	1 Co + Co 1	60′ 4″	22′ 5″			110	21.5
	28	Co + Co	42′ 0″	14′ 0″			85	18.3
B	113	1 C + C 1	49′ 3″	—	79.9	32.1	112	14.3
	84	2 C + C 2	59′ 5″	—	74.84	32.82	107.66	14.4
	41	1 C + C 1	49′ 8″	—	—	—	99.5	13.9
	31	1 C + C 1	49′ 8″	—	—	—	99	14.1
	27	(B-B)-(B-B)	61′ 0″	10′ 2″	74.2	41.8	116	14.5
C	102	2 C + C 2	69′ 0″	—	—	—	238	25
	91	2-C-2	49′ 10″	—	—	—	197	38
	37	2 C + C 2	69′ 0″	—	—	—	230	25
	28	C	12′ 8″	—	—	—	78.5	26
E	8	Bo — Bo	49′ 6″	6′ 11″	—	—	29.8	7.45
	8	Bo — Bo	54′ 0″	7′ 11″	—	—	33.4	8.35
F	15	Bo — Bo	29′ 6″	9′ 3″	—	—	60.4	15.1
G	58	Bo + Bo	35′ 0″	11′ 6″	48.2	38.5	86.7	21.7
	7	Co — Co	46′ 2″	15′ 8″	64	38	102	17
H	41	C + C	54′ 11″	15′ 1″	—	—	123	20.5
	23	1 - Co - 2	39′ 0″	—	—	—	102	21.15
	7	Co — Co	50′ 7″	15′ 9″	—	—	123	20.5

ction otor	Diameter drvg. wheel inches	Voltage	Tract. motors. cont. rating			Arti-culated bogies	Gear ratios
			No.	Horse power per motor	Total		
.1	48	3 000 DC	4			Yes	1 : 4.41
.6	51	3 000 DC	6	505	3 030	Yes	1 : 3.57
.1	48	3 000 DC	6	450	2 700	Yes	1 : 3.09
3.5	49	1 500 DC	6	295	1 770	Yes	1 : 4.15
3.5	49	1 500 DC	6	295	1 770	Yes	1 : 2.68
3.1	49	1 500 DC	6	242	1 450	Yes	1 : 4.15
3.5	49	1 500 DC	6	—	—	Yes	1 : 4.15
3.5	49	1 500 DC	8	295	2 360	No	1 : 3.67
—	57	11 000 AC	6	—	—	Yes	1 : 3.20
—	72	11 000 AC	3	—	—	—	1 : 3.89
—	57	11 000 AC	6	—	—	Yes	1 : 3.60
—	62	11 000 AC	3	—	—	—	1 : 5.44
0.8	33	1 500 DC	—	—	—	No	1 : 4.5
1.2	36	1 500 DC	—	—	—	No	1 : 4.6
3.6	43.5	600 DC	4	300 (lhr)	1 200	No	1 : 2.48
.4.3	50	1 500 DC	4	340	1 360	Yes	1 : 4.12
2.9	43	1 500 DC	6	400	2 400	No	1 : 3.76
—	48	1 500 DC	6	582	3 492	Yes	1 : 4.15
—	63	1 500 DC	3	333	1 000	No	1 : 3.66
—	48	1 500 DC	6	630	3 780	No	1 : 3.69

review, 25 000 V 50 cycles is being introduced on a considerable length of track.

DC systems vary at 600, 750, 1 500 and 3 000 V, the first and last covering the biggest and about equal mileages, but the 3 000 V is being rapidly extended on one large system.

The number of locomotives which form the subject of this report is approximately 1 200.

The average annual mileage per locomotive varies considerably, being influenced greatly by the length and character of the routes and traffic. It appears that the general average mileage for passenger locomotives is 70 000-80 000 with a maximum average of one large class of 112 000 and for freight traffic about 50 000. These figures in some cases appear to be lower than might have been expected.

Data of « Principal Classes of Locomotives » is shown overleaf.

Brakes. — The standard method of braking appears to be cast iron brakeblocks applied to the tyres supplemented by regenerative and, in one case, rheostatic braking, principally on lines where gradients abound. There is no indication of the use of non-metallic brakeblocks on electric locomotives.

Speeds. — The maximum speeds for passenger locomotives reported is 100 but 75 to 90 is a more general range of maxima and in most cases the designed maximum speed is above the permitted speed of the lines. The general running speeds of passenger trains are 50 to 65 and of freight trains 30-35 m.p.h.

II. Wear of rails and tyres.

The general practice on electric locomotives is to use wheel centres with tyres, but in some cases monoblock or solid wheels with tyre profiles are used, but such applications are on guiding wheels only.

Rails are generally of medium manganese steel, manganese ranging from .60 % to 1.20 % with carbon .50 % to .82 %, maximum sulphur permitted varies from .06 % down to .04 % and phosphorus .05 % down to .04 %. As heavier rail sections are used there appears to be a tendency to increase carbon and manganese contents. Tensile strength varies from 65 tons/sq.in. to 35 tons/sq.in. with elongations of 8 % to 12 %.

Tyre steel has a very similar composition to that of the heavier rails, maximum carbon being slightly lower but manganese and silicon approximately the same, maximum sulphur and phosphorus .05 % tensile strength about 60 tons/sq.in. with elongation 10 %.

There is no indication that the composition of rail steel has been modified on account of electric locomotives but the remarks above re-heavier sections of rails may be relevant.

It appears, therefore, in general that a state of equilibrium has been reached in which the hardnesses of rails and tyres are equal and probably this is desirable in order to reduce adverse effects of one upon the other.

Reports indicate that the useful life of rails under electric traction is less than with steam traction but a quantitative comparison is difficult as there is generally an increased service under electrification. The reduced life may be of the order of 20 %-50 %. One administration reports that this reduction applies to rails on curves but not on straight. The limiting forms of wear vary as between batter at rail ends, side cutting, top wear and in some cases corrugations which may occur chiefly on sharp curves. In one case corrugations are reported to occur on sharp curves with a wave length of 24-30 inches. When the depth of corrugations reaches 3/16", rails are renewed.

It is clear from the information obtained that geographical circumstances vary very greatly between administrations and consequently the mileages which can be run before tyres require reprofiling vary from 26 000 to 250 000. The factors affecting this are chiefly :

(1) Passenger or freight service;

(2) Curvatures;

(3) Gradients;

(4) Length of haul between stops;

(5) Slipping, which will be influenced particularly by (3) and (4).

No. (2) will largely govern the amount of wear into flanges and No. (5) will be the greatest factor causing tread wear.

Various combinations of these factors will produce a great number of limiting mileages. There appears to be definite indication that flange wear on curves can be considerably reduced by track oilers.

Tyre wear in some cases necessitates the locomotive being taken out of service between normal heavy repairs but in other cases it is corrected whilst other work is being carried out. The provision of track oilers has in some cases enabled tyre profilling and other repairs to be brought together.

There is much variation in the limits of wear permitted and these can also be subdivided into stage limits and final limits. The stage limits can be regarded as the wear permitted before the profile must be reformed as distinct from the final limit which will govern the minimum thickness at which a tyre can be permitted to remain in service.

On stage limits, tread wear allowed varies from 1/4" (6.3 mm) to 3/8" (9.5 mm) sometimes governed by a maximum depth of flange of 1 1/2" (38 mm). Flange wear permitted varies from 1/4" to 1/2" (6.3 mm to 12.7 mm) the general point at which this is measured being 9/16" (14.3 mm) from the top of the flange, the minimum thickness at this point being 3/4" (19 mm). In only two specified limits is there any mention of the final angle of the worn face of flange; it must not become less than 17° and the tip of this face must not approach nearer to the top of the flange than 3 mm (1/8") when this angle is reached.

The final limit, in conjunction with flange limits quoted above, occurs when the minimum thickness of tyre in the centre of the tread is reached and the lowest figure specified for this is 32 mm (1.28").

The maximum flange wear generally occurs on the outer wheels of a locomotive, be this guiding or driving wheel.

It has not been shown that the rate of wear is affected by wheel diameter relative to the nominal or new diameter.

No general agreement is indicated to limitations of axle-loading relative to wheel diameter. There are indications that thought is being given to this and some administrations have in mind a figure of 4.5 to 5 tons (axle load) per foot of diameter. Such figures, however, may place onerous restrictions on locomotive design.

General opinion appears to favour articulated bogies and it is claimed that reduced flange wear results from this provided that there is freedom of movement of the inner headstocks of the bogies and that there is a centring device on the coupling.

It is clear that there is a strong opinion on the economic value of lubrication to reduce both flange wear and side cutting of rails. The use of rail lubricators is much more prevalent than flange lubricators fitted to locomotives. These may be automatic pump dispensers operated by passage of vehicle using a grease or felt pad type feeding oil.

The effect of method of suspension of traction motors on rail or tyre wear cannot be assessed as most administrations have to date only nose-suspended motors. One administration reports that this method causes more tyre wear than frame mounted motors.

When tyre profiling is necessary wheels are removed from locomotive and tyres are returned in heavy duty wheel lathe using high speed or tungsten carbide roughing tools or buttons, finishing with profile former tools.

Release of the locomotive when requiring tyre turning only may be greatly accelerated by changing bogies. Worn flanges are not built up by deposition of weld metal and there are no reports of the use on electric locomotives of tyre profiling machines for reforming tyres in situ under locomotives. A machine for doing so is being installed by one administration.

III. Traction motors.

There is general uniformity in certain features of traction motors reported, viz. :

- DC motors 4 poles with 4 auxiliary poles;
- Roller bearings on armature shafts;
- Axle-hung bearings — bronze shell with white metal lining — one administration reports roller bearings on all locomotives;
- Lubrication to axle bearings, oil with pads, waste packing or wicks.

On the two AC systems the motors have 12, 16, 18 and 20 poles with corresponding numbers of auxiliary poles and brushes.

Brush holders follow a uniform pattern adjustable only for radial gap but brushes vary between solid and divided with and without flexible connections.

Arcing horns are being increasingly used to prevent damage to commutators by flashovers.

Weight of traction motors varies from 1.7 tons up to nearly 5 tons. One administration reports weight as less than 1 ton — this is a small line and may be for light duty only. The transmission of power from motors to axles is predominately unilateral but there are also bilateral gears. Involute, straight and helical teeth are employed. Gear cases are split about the shaft axes and are principally of sheet steel but some cast steel cases are used. Seals to prevent oil creepage to the armatures are important.

Maintenance and repair of traction motors follows a fairly uniform pattern with some variation in the periods and mileages as shown by the following table :

	Period between inspection of brushes, etc.	Period between overhauls	Mileage between overhauls	Remarks
A	21 days			
B	25 days	4 years	46 600 - 186 410	Intermediate repair annually
C	monthly		300 000 - 400 000	Also daily inspection
D	twice monthly		125 000 - 375 000	
E	monthly		50 000 - 62 500	(Inspection)
F	monthly	3 years	100 000	
G	35 days	5 years	250 000 - 400 000	
H	45 days		150 000 - 250 000	

The short period inspection at periods ranging from 15 to 45 days in the various administrations is primarily concerned with brushes and commutators, the former particularly to ascertain that there is sufficient length remaining to enable the brushes to function satisfactorily until the next inspection. This is similar when a daily inspection is carried out and on this line a megger test is made at the monthly inspection but on other railways this is not usual.

At the overhauls the motors are dismantled, inspected and tested, cleaned out by vacuum and compressed air; commutators turned, varnished and baked. In general it is not intended that the full repair should be necessary before a large mileage has been run over a number of years but

it would appear that in some cases this is actually done more frequently.

It is unusual for the locomotive to be stopped specially for motor repairs but these are carried out when repairs to other parts, i.e. tyres are required.

Insulation is generally to Class B but there is a trend towards improved insulation by using inorganic materials such as glass fibre.

Brush pressure is set when motors are assembled and it is not expected that great variation will occur, but if hand testing casts any doubt upon the pressure being exerted a test by spring balance is made.

There is a fairly close tolerance specified in the thickness of brushes new and in the slots of brush holders. It is generally appreciated that it is detrimental to the life of brushes to allow them to be very slack in the holders. There are only two cases reported of limiting clearances, these being .25 mm and .3 mm (.010" and .012"). These limits are only slightly greater than the initial clearance permitted by other specifications and it is thought that most railways permit at least double these figures. Commutators are not expected to require returning other than at heavy repairs which are at mileages above, say, 300 000 miles and then the cut should not be more than .010". In one case, however, it is reported that it is done at three years and mileage of 100 000 but this is on a suburban passenger service with very short distances between stops.

Motor design in most cases allows of the armature shaft being withdrawn without dismantling the armature but it does not appear to be so designed primarily for the purpose of crack detection in the shaft.

In sequence with the increasing use of ultrasonic methods for axle examination, these are being extended to armature shafts supplementary to visual and magnaflux methods.

This is done at major overhauls but it appears from replies that the incidence of cracks in these shafts is practically unknown. Armature bearings also are only dismantled for examination or replacement at the heavy overhauls.

As previously mentioned, roller bearings are not used for motor suspension and, therefore, no cracking of axles has arisen from the use of them. No special means other than the axle bearings and the suspension links are employed to ensure correct meshing of pinions with gear wheels.

In the fitting of pinions to armature shafts there are opposing practices in providing or not providing keys, but fitting of keys preponderates. It is fairly universal practice to provide taper seats for the pinions (taper of 1 in 10 is quoted in one case); to require bearing on the shaft of 80 % of the area and then to shrink on at a temperature of 95° C to 105° C either by soaking the pinion in boiling water or in an oven. The pinion is then tapped into position or assembled in a press and where a locking nut is provided this is assembled and locked in position as quickly as possible.

Opinion is also divided upon the question of whether it is necessary to keep pinions and gear wheels matched, i.e. if it is necessary to change a motor without changing the wheel and axle to transfer the old pinion to the replaced motor. Three organisations say no and a fourth, which used to carry out this practice, has abandoned it on the ground that it is not worth the expense and also from the fact that one spur wheel lasts the life of two pinions. It is unusual for traction motors to be changed at other than main works except in cases of emergency.

Flashovers on electric locomotives appear to be rare and when they do occur are generally caused by frost or snow, contamination by smoke and exhaust from steam locomotives or by lightning. There are, however, varying devices to assist in current collection, viz. :

- Use of two pantographs or one pantograph with two shoes to reduce current collection per pan or pantograph;
- Two or more collecting strips on each shoe;

Auxiliary springs to help shoe follow the wire;

Air vane on high speed locomotives to keep shoe level;

Fitting of arrestors on locomotives to limit surges caused by lightning;

Instructions to train crews to limit current and fine division of resistances to assist in this;

Separate wheel slip indicators are fitted in a few cases but crews are also taught to deduce this from armature field meters.

Snow or rain ingress to traction motors causes trouble in some regions and this is countered by fitting screens. In other cases where the air is drawn from the body of the locomotive the louvres and filters provide sufficient protection.

IV. Lubricants.

Lubrication of armature bearings is by grease or high viscosity mineral oil. The greases used are generally composed of refined mineral oil and soap or calcium.

There appears to be a little more variation in the lubricant for the axle or hollow shaft bearings of traction motors, from greases composed of refined mineral oil and soap, high viscosity mineral oil to a light machine oil.

Heavy gear compounds are used for gears and this is applied by very orthodox methods of grease guns. There have not so far been reports of the use of any radically new lubricants. Not much trouble is experienced from leakage of gear lubricants towards the armature shafts but there are indications that this is liable to occur and provision and maintenance of effective seals are necessary.

V. Pantographs.

It appears that considerable attention has been paid to the selection of the most suitable material for pantograph strips. Copper strip and also carbon strip were used on railway B before sintered metal was adopted. Copper was found to wear too heavily and carbon limited current collection. On some other lines there is a tendency to use carbon and one line is experimenting with carbon impregnated with babbitt. Compound strip of copper and steel side by side have also been used with some improvement and in one case the application of molybdenum disulphide grease as an anti-scuffing medium has indicated reduced wear of the strips.

The life of strips is reported as ranging between 10 000 and 30 000 miles and varying factors influence the rate of wear. Increased wear is attributable to wintry atmospheric conditions, high speeds, contamination of the contact wire by steam locomotives where these operate. There are, however, contradictory reports on the effect of wet weather. The table on the following page gives an indication of experience on the reporting administrations.

Pans are examined for wear at short and long period inspections and changed when the limit of wear is reached. General practice is to exchange pans but in one case strips are renewed whilst pans are left in position. Between these periodical examinations of strips, complete pantographs are only examined superficially from the ground. Pressure is tested at each long period inspection.

Graphite grease is the general lubricant used — it is efficient and can be easily and quickly applied. At inspection grease is added if required and if the old grease has hardened it is scraped away and replaced by fresh.

In one design of pan two copper strips running the length of the pan along the outer edges are augmented by two additional strips 18" long in the centre of the pan. The contact length is, therefore, four inches at the most used portion of the pan. The outer edges of the long strips are provided with a radius.

At the maintenance depot of one line, the pantograph shop is on the first floor, above the roof level of locomotives and a hand operated platform is arranged to be able to be traversed out from the shop

Railway system	Wearing strips			Permitted wear	Lubricant	Pressure lbs.	Stagger inches	Life mileage	No. of locos.	Average speed m.p.h.
	No.	Dimension	Material							
A. DC 3 000 V	4	1″ × 1/4″	Copper with 1 % cadmium	1/8″	Graphite grease	—	—	—	265	35-55
B DC 600-1 500 V	8	1″ × 3/8″	Sintered Copper Tin Iron Nickel Graphite	1/4″	Graphite grease	10-12	10	20 000	323	45-50
C. AC 11 000 V	2	4 3/4″ × 1/8″	Copper bearing steel	—	Graphite grease	—	on curved track only	6 000	268	55-65
D AC 15 000 V	1	1 3/8″ × 2 1/4″	Carbon	3/4″	nil	—	—	25 000	—	40-65
E DC 1 500 V	2	1 3/4″ × 9/16″	Aluminium 90 % Copper 10 %	3/8″	grease	6	—	(5-8) (weeks)	6	28
F. DC 600 V	fourth rail system			—	—	—	—	—	15	—
G. DC 1 500 V (operates with 2 pantographs 4 strips on each pan)	8	1 1/4″ × 1/4″	Copper	3/16″	Graphite grease	16	15	10 000	65	45-65
H. DC 1 500 V	(*)	1 3/16″ × 1/4″	Copper bearing steel	3/16″	Graphite grease	—	—	30 000	73	34

(*) It is not quite clear whether these are two or four strips.

above the locomotive to facilitate changing either pan or, if necessary, complete pantograph. On other lines, mobile platforms are provided to facilitate access to the pantographs.

Formation of ice on pans is not found to be a trouble but it is considered that the grease used as a lubricant also acts as a preventative.

VI. Organisation of the maintenance done and periodicity.

The maintenance of electric locomotives falls into a general pattern but the actual figures of time and mileage between repairs vary very greatly according to characteristics of each railway system.

It is exceptional for a daily examination to be made other than that carried out by train crews on taking over or giving up a locomotive (see Section VII). The maintenance systems provide for (*a*) inspections, (*b*) General Overhauls and (*c*) an intermediate or lighter repair between (*a*) and (*b*) necessitated by attention to tyres or bogie. As the variations in periods and mileages between these are so great, it is thought desirable to give a table showing the ranges of these.

Railway service	Inspection		Intermediate overhaul		General overhaul	
	Short period	Long period				
	Days	Days	Years	Mileage	Years	Mileage
A.	1	21	—	120 000	—	750 000
	—	21	—	200 000	—	not yet fixed
B.	—	25	1	10 000	4	46 000
	—	25	1	47 000	4	186 000
C. freight	1	30	—	—	—	300 000
passenger . . .	1	30	—	—	—	400 000
D.	—	—	—	—	—	125 000
	—	—	—	—	—	250 000
E.	—	14	—	—	—	50 000
G. freight	7	35	—	70 000	5	250 000
passenger . . .	7	35	—	100 000	5	400 000
H.	—	6 000 miles	—	50 000	—	150 000
	—	8 000 miles	—	125 000	—	250 000

The general overhaul includes a complete strip down of mechanical and electrical gear and renovation or repair of all components. A number of intermediate repairs will be carried out between general overhauls chiefly depending upon tyre wear.

The period found necessary to carry out repairs varies considerably depending upon the extent to which spare parts are exchanged. This greatly facilitates the intermediate repairs, particularly when spare bogies are utilised.

A short period inspection requires 1 to 2 hours, long period 6-10 hours, intermediate repairs vary from 1-2 days for change of bogie to 10 days and general repair from 11 to 30 days, the longest time occurring when the stage is reached at which insulation of cables, etc. is breaking down and complete re-wiring is necessary.

Much attention has been given to endeavours to increase the length of period between heavy overhauls, principal items being :

- Reduction of tyre wear by provision of flange or rail lubrication;
- Improved lubrication of axle bearings by felt oilers and substitution of roller for plain bearings;
- Improvement of grade of insulation;
- Analysis of condition of parts dismantled to ascertain if periods between dismantling can be extended;
- Quick exchange of individual components in connection with this analysis and reducing the number of components dismantled.

All maintenance work is carried out at Works or Depots other than short daily inspections where these are instituted. All intermediate and general overhauls are carried out at the Main Works at the periods quoted.

The limiting factors which influence inspection and shopping periods are chiefly pantograph strip wear, brake block wear and adjustment between inspections and tyre and commutator condition for longer period repairs. Statutory requirements also influence short period examinations in some instances.

The repair liability is carefully planned by each administration which can deduce, from anticipated total mileage expected to be run during each year and the known mileage which each class of locomotive can run between repairs, the number of repairs of various categories which will be required during a year in order to maintain the stock in serviceable condition. The short period inspections can be controlled on a purely time basis and there appear to be fairly common systems of central shopping controls which regulate the allocation of locomotives to Works for repairs.

All administrations report that the changing of bogies is carried out at Main Works and it is important that the repairs to the bogies removed are put in hand quickly to maintain availability.

The direction in which management has moved in endeavours to shorten time of locomotives under repair are in the provision and maintenance of spare parts and interchangeable assemblies, analysis of method of carrying out repairs and of the wear which takes place in order to eliminate or reduce the wear and consequently the need to repair or change and, as tyre wear is one of the major influences, attention is being directed towards the use of machines for reprofiling tyres which are in position under the locomotives.

VII. Organisation of the service and effects of common user of the locomotives.

It is universally reported to be the practice to employ electric locomotives in a pool in common user. Locomotives are not allotted to a particular driver, or small group of drivers. Where the length of run is great, crews will be changed en route in order to work the locomotive through and to reduce terminal and turn-round time. Where the length of track is great, the limit of crew's operation may be governed by the distance over which they are required to learn the road. A number of electrifications

at present extend only over shorter distances so that change of crews during a run is unnecessary. But common and intensive user of locomotives is the general practice, utilising them again as quickly as possible after completing a trip.

When not required for traffic, locomotives are either stood by in sidings to await their next roster or if it is more convenient they are returned to depot but normally they are only specially taken to a depot if required for periodical maintenance or if a specific defect has developed. In some northern lines, climatic conditions make it desirable to stand locomotives in sheds if not actually required in service.

The system of common user and shutting down in sidings is so universal that no alternatives have, at any rate in recent years, been considered and no disadvantages can be elicited by any comparisons. It does emerge, however, that training of engine crews is important in order that they may handle them intelligently. Much care is taken in organising and carrying out this training. An important corollary of this is for them to report any defects or symptoms when they hand over or shut down a locomotive.

The amount of examination which a crew is required to make varies but in most organisations it is very small, being chiefly superficial inspection of brake-gear, sand-gear and lights.

VIII. Cost of maintenance of electric locomotives.

It is very difficult to make accurate quantitative statements of maintenance costs in different countries on account of differing currencies and labour rates. It was, therefore, felt that the only figure which could be quoted should be as a percentage of capital value of the vehicles although even this basis may be complicated by a variety of differing circumstances.

Heavy overhauls appear to cost up to 3.8 % of value for labour and materials (2 % labour, 1.8 % material), but figures down to about 2 % total are quoted. Long period inspections cost very much less and these are of the order of .05 %. There is a very considerable variation in manhours reported as may be expected from the above figures, ranging from 2 000 to 6 000 and these may be greatly affected by the size and rated power of the locomotives. The administration which reports one of the highest manhour figures for general overhaul quotes a relatively short period out of traffic of locomotive for this work. The manhours required for long period inspection vary over the maintenance cycle between 24 and 115.

In general it is not considered that there is a relationship between maintenance costs and age of locomotives, although one administration does think it so and estimates costs according to a formula based on age.

Counteraction of any tendency towards rising costs is being sought in improvement in design, manufacturing and repairing methods and reduction of wear, particularly with the aim of reducing the periodical maintenance required and extending the time between maintenance operations. Any achievement in this direction will enable increased mileages to be obtained with a reduction in the number of locomotive units required and in the maintenance cost per mile.

[656 .212]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID. 1958).

QUESTION 5.

a) Handling facilities in the goods depots for consignments in less than carloads; containers. General arrangement of the depots. Liaisons between the staff of the depot and the delivery services.

b) Railway problems regarding the introduction of general palletization of packages.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, Netherlands, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, Union of Soviet Socialist Republics and the United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by J. Dorjee,

General Manager of the General Transport and Forwarding Company VAN GEND & LOOS Ltd. (Holland).

CONTENTS

PREFACE.

The Questionnaire sent to 33 Administrations and to 2 Associations of Railway Administrations has been replied to by 13 Administrations and by the Association of American Railroads. Of the Swedish private railways the *Grängesberg-Oxelösunds Railways* replied with a reference to the answer of the Swedish State Railways, the *Nordmark-Klarälven Railway* with a reference to the reply of the *Union of Swedish Private Railways* and these in their turn referred to the reply of the Swedish State Railways, while the *Nora Bergslags Railway* stated that the questionnaire was applicable to their traffic only in a very limited degree. The *Transport Department of Tasmania,* the *Department of Railways of New South Wales,* the *Victorian Railways* and the *Sudan Railways* pleaded shortage of staffs in excuse and the *Uruguay State Railways* lack of time. The *Rhodesia Railways* were not in a position to answer the questionnaire, while the *Nigerian Railway Corporation* stated a number of circumstances on the score of which they were of an opinion not to be able to supply a useful contribution to the report. The *London Transport Executive* communicated, as may easily be understood, that the questionnaire was not applicable to that undertaking! « The rest was silence. »

The Administrations and Association the answers of whom were included in this report follow hereunder:

British Railways;
Ceylon Government Railway;
East African Railways;
Eireann Railways;
Indian Railways;
Malayan Railway;
Netherlands Railways;
New Zealand Government Railways;
Norwegian State Railways;
South African Railways;
Soviet Union Railways;

Swedish State Railways;
Association of American Railroads.

Reporter wishes to express his most sincere thanks to all Administrations who have taken pains and trouble in preparing their answers to the questionnaire. He would especially like to thank the *Swedish State Railways* and the *Soviet Union Railways,* who by their full and detailed information have contributed in a large measure in the fulfilment of his task. Likewise reporter wishes to express his sincere thanks to his colleague, Mr. Marchand of the French Railways, for his kind co-operation at the difficult task of drawing up the questionnaire. Finally he takes the liberty to thank those members of the staff of his company, who by their assistance have lightened his task.

CHAPTER I.

GENERAL ASPECTS OF PARCELS TRAFFIC.

1. Characteristics.

1. — *Please give the characteristics and importance of the parcels traffic handled by your Administration;*

— *weight limits for packages, grouped consignments and bulk goods that cannot be divided up included in the parcels traffic.*

Not all reporting Administrations supply characteristics of their parcels traffic. Insofar supplied these vary, but naturally correspond in this respect, that parcels traffic is understood to consist of consignments (= one or more packages on one consignment note) which are less in volume or weight than a carload. The differences mainly lie in the character and extent of further limitations imposed on the consignments or on the packages. Most limitations only relate to the packages: volume, dimensions, weight, unwieldiness.

The limitations to the consignments — minima and maxima — are in those cases imposed by the consigner himself in his own interest; these are subject to the results of his calculations in accordance with tariffs for parcels and carloads, of the cost for loading and unloading of carloads, the cost for the pre- and post transport of parcels and carloads and of other data. The *East African Railways* draw the attention to this in so many words; they observe « no weight limitation is imposed on smalls traffic, but, for certain types of produce and raw materials, which are normally carried in bulk, an inducement to consign in full wagon loads is made in the form of special rates subject to a minimum load factor ».

The *Indian Railways* likewise report that in a number of cases consignments offered for dispatch in wagon-loads are charged at lower rates than as « smalls » and consigners are encouraged to avail of the cheaper wagon-load rates by clubbing « smalls » consignments up to a maximum of 4 per consigner per wagon, so as to make up a full wagon-load. The *British Railways* reply that « consignments of traffic in less lots than one ton from one sender to one consignee, with certain minor exceptions, come under the classification of « Sundries » (parcels) traffic for which no weight limit per package is applied ». This, however, should undoubtedly be thus interpreted, that senders need not tender such lots as carloads and not that bigger lots tendered as parcels will be refused.

This also applies to the regulation of the *Swedish State Railways* that goods weighing up to 2 500 kg are forwarded as « fraktstyckegods » (= parcels as a rule forwarded by normal goods trains). The regulations of the latter also give an example of considerations other than those of the costs which may induce the consigner to impose a minimum limit to his consignments : for consignments of 20-50 kg freight must be prepaid. The *Indian Railways* report that consignments weighing 250 maunds (9.2 tons) and up on the broad gauge (5′-6″) railways and 160 maunds (5.9 tons) on the metre gauge (3′-3 3/8″) and the narrow gauge (2′-6″ or 2′-0″) railways are deemed to be « wagon loads » and those

weighing less « smalls ». The *Ceylon Government Railway* do not impose weight limits in parcels but remark that, as a rule, consignments heavier than 1 1/2 cwt (75 kg) are not tendered as parcels traffic. This low maximum is due to the fact, that in this railway parcels traffic is dealt with only at passenger stations and despatched in guard's brake vans. As no parcels are dealt with in goods depots, strictly speaking the parcels traffic of this Administration cannot be included in our study.

Explicit *limitations concerning unit packages* are made as well as weight maxima as in other forms.

Union Railways which will be dealt with presently, there presumably are weight limits for packages lower than respectively 3 and 5 tons. *British Railways, Eireann Railways, Indian Railways, Norwegian State Railways* and the *Association of American Railroads* report that no weight limit per package is applied. In addition to this *Eireann Railways* report that unit packages and grouped consignments, which are too big or awkward to be handled through the goods sheds, are dealt with at carway or loading bank with cranage assistance if necessary. It is obvious to presume that this is also applicable for all other Administra-

Weight maxima for packages.

Administration	*Max. weight*	*Remarks*
Malayan Railway	10 cwt (500 kg)	heavier packages are not dealt with at sheds.
Netherlands Railways	500 kg	are fairly often still accepted if they are easy to handle.
South African Railways . . .	250 lbs. (113 kg)	if destined to stopping places where no staff are on duty.
	3 000 lbs. (1 360 kg)	packages exceeding this weight are not collected or delivered at stations other than certain of the larger depots.
	20 tons	provided special provisions can be made beforehand for the transport of a particular package.
Soviet Union Railways	± 6.5 tons	if loading is carried out at consigner's own sidings in direct wagons for delivery at one single station.

Besides the limitation for a special case mentioned in the table the *Soviet Union Railways* in their reply mention no further limitations for individual packages. With a view to the maxima to be mentioned hereafter of 3 and 5 tons for consignments which are already lower than the limit for packages mentioned in the table and with a view to the dispatch system of the Soviet tions which do not apply a weight limit or other limitation per package (see also *Malayan Railway* in the above table). This way of handling of parcels traffic without making use of the goods stores or sheds is as a rule not executed by the subsidiary company (N.V. Van Gend & Loos) of the *Netherlands Railways* which only very rarely accept as parcels goods which owing to

their length, width or height cannot be loaded through the sidedoors of an ordinary covered wagon of maximally 15 tons load capacity. The *Norwegian State Railways* report the special condition that they may demand consignments consisting of small packages, which might cause delay in handling and transport, to be put in boxes, baskets or sacks or assembled into bigger packages. A condition of the kind exists at the *Netherlands Railways* but is very seldom applied especially since the subsidiary company N.V. Van Gend & Loos have switched to overall palletization. The *Indian Railways* have the regulation that the *minimum* weight for a package is 7 seers (14 lbs); in special cases, however, packages of less than 7 seers are also accepted if their sizes are convenient for transport.

A clear case of limitation of the size of consignments according to volume and or weight by the Administration itself is found, as appears to reporter, at the *Soviet Union Railways.* These stipulate, that the quantity of freight tendered for despatch as parcels traffic may not exceed in volume one third of the capacity of a wagon with a weight limit of 20 tons, and in weight 3 tons for parcels traffic offered through station goods sheds or the offices of consigners who use container transport of their own and who do not work according to a « planned norm » and 5 tons if the consignment is part of a « planned norm ». That the Soviet Union Railways themselves fix limits to the consignments in parcels traffic and do not make these subject to consigners' calculations fits in — as it appears to reporter — with their total « plan economy », as is the case with the higher limit for consignments being of a « planned norm ».

One of the general characteristics of « parcels traffic » is that it always concerns « broken transport » either already within the railway system itself (transhipment), or at the door to door transport. Pointing to this may seem as much expressing a commonplace as it is to define « parcels traffic » as traffic in consignments less than carloads. However, it is this characteristic in particular which defines the whole contents of « question 5 » and demands all care and attention for what it embodies (handling facilities, arrangement of depots, delivery services, palletization), even if it were only in order to prevent « broken transport » resulting in « broken goods ».

2. Importance and evolution.

— *annual tonnage compared with the total freight tonnage;*

— *present evolution; has there been any increase or any decline in the parcels traffic dealt with in the Goods Depots?*

The Administrations have adhered to the (non-limitary) indications of the questionnaire and have merely indicated the *importance* of the parcels traffic within their own system, expressed in the annual tonnage compared with the total annual freight tonnage.

The data supplied concerning the present *evolution* vary from vague indications to a series of index number (Soviet Union) and detailed tonnage tables (Netherlands, Sweden).

The great differences in relative importance of the parcels traffic cohere with the great differences in economical structure and — in this — the structure of the total transport system of the countries in question. Every Administration will want to remain constantly aware of this coherence, for the evolution of these structures is decisive for the evolution of their parcels traffic and for the measures to develop, adapt and — if necessary — to defend same.

Characteristic in this connection are the few figures of the *Swedish State Railways* related here and the probable causes mentioned of the course of these figures; likewise the remarks of the *Malayan Railway* and *New Zealand Government Railways.* « Road competition » is the omnipresent threat, highest efficiency of the parcels traf-

Administration	*Year*	*Annual tonnage*	*Perc. of total freight tonnage*
British Railways	—	5 000 000	1.8
East African Railways	1956	646 000	16.6
Eireann Railways	—	450 000	20
Indian Railways	1955/56	4 842 000	4.2
Malayan Railway	—	100 000	5
Netherlands Railways	1956	1 398 000	5.3
New Zealand Govt. Railways	1956	494 000	4.6
Norwegian State Railways	—	—	12 *
Soviet Union Railways	1956	4 970 000	0.3
Swedish State Railways	1956	1 246 000	3.0 } 2.7
Swedish Private Railways	1956	96 000	1.5 } 2.7
U.S.A. Class I. Railroads	1955	7 000 000	0.5

* Express and accelerated goods traffic included in parcels traffic tonnage. Iron ore traffic of the Ofoten railway not included in total freight tonnage. (The dispatch as accelerated goods depends upon the weight, shape, volume and nature of the packages as regards their suitability for being quickly loaded, transhipped and unloaded, the judgement of which is left to the dispatching station.)

fic system the parole. This in short may be looked upon as the philosophy behind question 5.

For that reason besides the internal proportional figures supplied, a single figure about the share of the railway parcels traffic in the total national parcels traffic would even in this short framing sketch have been in place. It is known, however, that in most countries no reliable figures hereof are obtainable.

3. Dispatch.

2. — *How do you organize the despatch of the parcels traffic?* (1).

Do you authorize the running of wagons as required (optional runnings).

If you do, for what weight limits?

In a footnote to question 2 in the questionnaire the reporters have defined the « classical organization » of dispatching the parcels traffic as an organization in which the whole countrywide system has been divided into regions, each of which is served from a regional head-station by trains or if necessary by road vehicles (lorries) for picking up and distributing the goods, each regional centre dealing with the tranship-

Administration	*Evolution*	*Causes (remarks)*
British Railways	progressive decline	road competition
East African Railways . .	increase approx. pro rata to the rate of	development of the East African Territories
Eireann Railways . . .	—	(relationship parcels : total freight fairly constant)
Indian Railways	× 1 000 t — perc. of total fr. — 1953/54 4,767 4.8 1954/55 5 293 5.0 1955/56 4 842 4.2	
Malayan Railway . . .	gradual but progressive increase	expanding economy of the country (road competition most marked)
Netherlands Railways . .	maintaining position × 1 000 t — perc. of total fr. — 1948 981 5.3 1951 1 002 4.4 1956 1 398 5.3	(in spite of strong road competition) (1951 business slump, unemployment) better organisation than road transport (complete network x single lines), extensive use of competitors' own weapon (lorry), commercial management.
New Zealand Govt. Railw.	gradually increasing	(prompt and efficient transport important partly to combat road competition).
Norwegian State Railways	downward tendency	part of the lost parcels traffic has passed over from parcels consignments to complete wagon loads arranged by private forwarding companies (comp. U.S.A.-railways)
South African Railways .	increase	—
Soviet Union Railways .	1950 : 100 1953 : 146 1956 : 216	—
Swedish State Railways .	tendency to decline × 1 000 t — perc. of total fr. — km (*) — 1948 1 691 4.7 198 1951 1 570 3.7 244 1956 1 246 3.0 275 (*) ton/kilometres : tons	— relatively long transport lines — road competition — altered procedures of trading (greater number of warehouses and more carloads between)
U.S.A. Class I Railroads.	consistent decline : 1920 : 53 000 000 t 1955 : 7 000 000 t	(1955 : 5 000 000 t LCL traffic consolidated by forwarding comp. to carloads)

ment of parcels for the through wagons to or from other regional centres (*).

Notwithstanding this definition the description of the organization at the different Administrations is not divided into « classical » and « non-classical » but into « regular runnings » and « optional runnings », because it is possible on the one side — at any rate theoretically — that a « classical organization » as defined above, has not « regular runnings » as its characteristic, whereas on the other side an organization which exclusively has « optional runnings » as its characteristic has a great many regular runnings in practice. Moreover, answers have been given, from which may be concluded that « regular runnings » is a main characteristic of the organization, but from which cannot be derived that the organization is « classical » in the sense of the above definition.

a) Regular runnings.

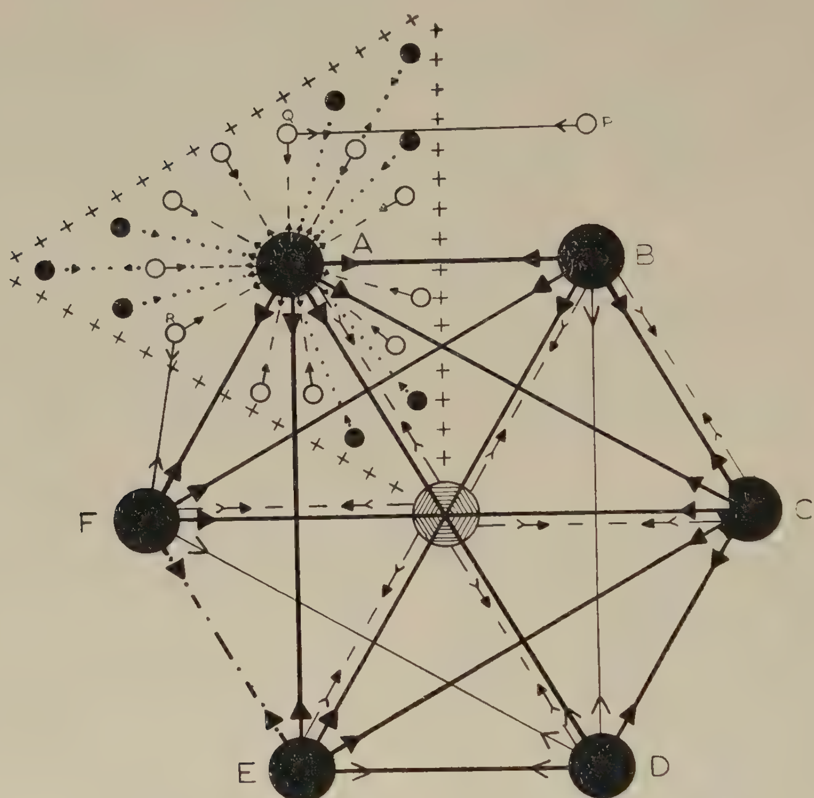
At the *British* and *Netherlands Railways* parcels traffic is dealt with according to the « classical organization ». In Great Britain this organization is known as a « Zonal Collection and Delivery Arrangement », in Holland as « the group system ». From the replies of the *Eireann Railways* and *Norwegian State Railways* reporter is inclined to conclude that both Administrations have regular runnings according to fixed plans. Eireann Railways reply that « wagons are placed in a fixed pattern in the Goods Store Wagon bays » whereas the *Norwegian State Railways* reply that « a general transport plan for all our lines for the runnings of parcels goods wagons is prepared for each timetable period; optional runnings are authorized. « The answer of the *Association of American Railroads* clearly shows, that for the railways in the U.S.A. regular runnings is a characteristic of the organization of the dispatch of parcels traffic : « Every railroad has authorized and established car lines or classifications, on line as well as off line. These classifications are dispatched daily, every day or in some cases, twice a week ». The five Administrations mentioned allow optional runnings. The *British Railways* condition one ton as minimum permissible weight of traffic constituting a wagon load; *American Railroads* 2.5-3 tons. *Eireann* and *Netherlands Railways* have not imposed weight limits for optional runnings but light loading of wagons is avoided as much as possible.

Of the British and American Railways reporter understands that by optional runnings are understood runnings to other destinations than those specified in their plans. The Netherlands Railways understand by these : runnings of wagons which are added to the regular wagons, if need be, and which consequently run exclusively to the stations specified in the plan. The *Netherlands Railways* have organized the dispatch of their parcels traffic in a strictly « classical » way (fig. 1). The main characteristics of this organization are :

1. all (35) regional head stations or zonal key stations — called « group head stations » in Holland — execute the transit:
   - of the goods arriving from their own group to the group head stations of other groups and to the secondary stations in the own group;
   - the goods arriving from other groups to stations in the own group;
2. in principle every group head station dispatches at least one wagon a day — called « group wagon » — to every other group head station;
3. almost all stations *in* the groups (secondary stations) which are served from the group head station by rail (59) send to and receive from the group head station at least one wagon (« dump wagon ») a day, which consequently contains goods bound for/originating from various stations;

(*) Your reporter wishes to observe that he does not interpret « classical » as « ancient » or « traditional ». Perhaps it might be interpreted as « of good style », distinguished and with that touch of efficiency inherent in classical structures.

Principle of the *Netherlands Railways* « classical » organization of parcels traffic dispatch (the « group system »)



Group head station.

Group wagons.

Optional wagons.

Group « wagon » by road.

Group head station with common group wagons with D in 3 relations (B, E, F).

Group wagon from A to D.
Optional wagon from D to A.
Dumpwagon.

Dump « wagon » by road.

Regular services of private road carriers.

Van Gend & Loos regular road services.

Van Gend & Loos central transhipment depot.

Secondary stations.

Stations of private road services.

Group (= region).

Not shown : regional collection and delivery service.

Fig. 1.
(Chapter I - 3 a)

4. some stations (9) *in* the groups, though with rail connections, are served by road vehicle;

5. in great parts of all groups the collection and distribution (from consigner and to consignee) is executed per lorry straight from the group head station including places which still have rail connections (regional pick-up and delivery service);

6. the group wagons run with great regularity, but only on weekdays, they depart late in the evening in special trains formed for the purpose and arrive during the night or in the early morning; the circulation-time for these wagons is one day, being unloaded in the morning and reloaded in the afternoon;

7. the dump wagons as well run with great regularity; they are transported in regional goods trains during the day, in the morning with incoming goods; in the afternoon with outgoing goods;

8. as group wagons and mostly also as dump wagons special closed wagons are used; these wagons are almost exclusively used for parcels traffic and can be instantly recognised by special marks (important for rapid shunting in the marshalling yards).

Owing to this organization a high percentage of the parcels traffic can be transported daily from door to door within 24 hours. The country being small and densely populated naturally contributes to achieve this object. The latter is also one of the circumstances which render the maintenance of a rigid organization of the parcels traffic service possible. Another consequence of this organization is that little transhipment from rail to rail takes place; in the vast majority of cases transhipment is from rail to road (pick-up and delivery service) vice versa.

For some group head stations which lie at short distances of each other, the service differs from the course stated *sub* 2; some jointly receive or send a group wagon from/to certain other group head stations (C and D in fig. 1). Some are linked to one or more other group head stations not by rail but by means of a road service (E and F in fig. 1). These are regular divergencies from the course mentioned *sub* 2.

Optional divergencies are met with also, for instance :

a) in cases that it is known in good time that for transport from/to « group head stations » which send/receive a common « group wagon » so much load is present that it is justifiable for those group head stations to send/receive separate group wagons, this is done (in figure 1 in the relations $B \leftrightarrows D$, $E \leftrightarrows D$, $F \leftrightarrows D$, and $D \leftrightarrows A$, and the relations $B \leftrightarrows C$, $E \leftrightarrows C$, $F \leftrightarrows C$, and $C \leftrightarrows A$);

b) in cases that a station has so much load for a secondary station in another group that it is justifiable to employ a direct wagon, this is done (in figure 1 the relations $P \leftrightarrows Q$ and $F \leftrightarrows R$).

The number of group wagons in regular circulation between the group head stations amounts to approx. 1 250, whereas daily approx. 75 extra group wagons are employed. The number of dump wagons employed daily is approx. 225. The average load per group wagon amounted in 1956 to 3.5 tons (maximum load 4 tons, minimum 3 tons).

With the exception of selling the services (acquisition) and running the railway wagons, the work (the greater part of the parcels traffic administration as well) is executed by the subsidiary company *N.V. Algemene Transport- en Expeditie Onderneming Van Gend & Loos* (General Transport- and Forwarding Undertaking Van Gend & Loos Ltd.) as contractors to the Netherlands Railways Ltd. This company, all the shares of which are held by the Railway Administration, run their own parcels traffic system — regular road services — parallel to but independent of the Railway parcels traffic system.

b) **Optional runnings.**

The *East African, South African, Malayan* and *New Zealand Government Railways* run direct wagons to all destinations when a sufficient load can be formed. Where the quantity of traffic does not justify direct wagons, the goods are loaded as transhipment goods in wagons conveying goods for more than one station to a specific transhipment depot. The *East African Railways* carry the traffic from the transhipment depot to minor stations in road vans and vice versa. They do not stipulate a minimum weight for the use of a direct wagon but leave it to the Agents and Station Masters to decide. On this point the *South African Railways* follow almost the same practice. The *Malayan Railway* authorizes a minimum of 2 tons.

As a variant to this, in principle rather uncomplicated dispatch system, the organization of the dispatch of the parcels traffic in the *Swedish State Railways* may be considered. Three categories of parcels-wagons are distinguished :

A-wagons, for goods only to the destination of the wagon;

B-wagons, for goods to the destination of the wagons and for goods which are to be transhipped there in order to be forwarded to other stations;

C-wagons, to be coupled to appointed regular trains on certain sections of the system to be loaded and/or unloaded at stations on their way.

A- and B-wagons as a rule run from the station of dispatch to their destinations without being loaded on their way. They are used :

a) to the extent indicated in the transport plans drawn up by the Railway Board;

b) by dispatch or transhipment stations for at least 3 000 kg of goods or so much in bulk that the wagon is fully packed, to one destination (A) or to the destination of the wagon and to other stations to which — according to plan — the goods are to be forwarded from the station of destination of the wagon (B).

C-wagons are used :

a) to the extent indicated by the plans drawn up by the Railway Board;

b) by stations on the section for at least 2 000 kg or so much in bulk that the wagon is fully loaded;

c) by stations as *sub. b*) for smaller quantities of goods if by so doing considerable delay of the train can be avoided.

Further characteristics of the Swedish organization are :

1. regulated transhipment points (a map on which the transhipment points are indicated leads to this conclusion) (fig. 2);

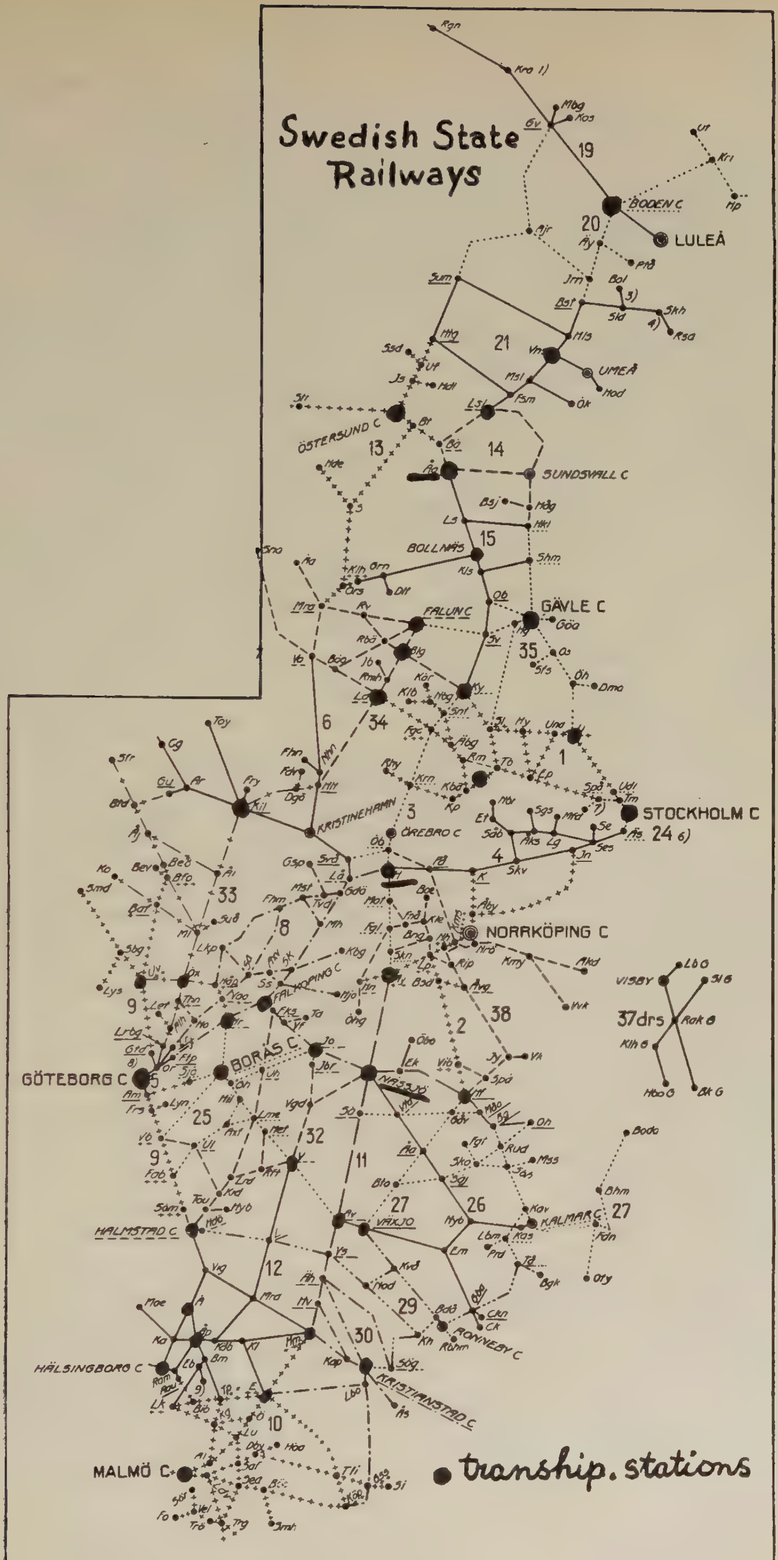
2. parcels are in principle forwarded on weekdays only;

3. the greater part of the transport-distance is bridged by A- and B-wagons; these as a rule run at night in fast long-distance goods trains; so that the goods arrive at their destinations or transhipment points early in the morning;

4. C-wagons collect and distribute the goods; they as a rule run in the daytime in slow goods trains which stop at all stations;

5. on sections with little goods traffic C-wagons and slow trains are to an increasing extent replaced by lorries.

On the whole system of the *Swedish State Railways* 2 500-3 500 wagons for parcels traffic are actively employed daily; 8 % of these are A-wagons, 52 % B-wagons and 40 % C-wagons. As the collection and distribution on the rail system are taken over to an increasing extent by lorries, the number of C-wagons will decrease considerably, whereas the number of B-wagons will slightly increase.



Swedish State Railways
BODEN C
LULEÅ
UMEÅ
ÖSTERSUND C
SUNDSVALL C
BOLLNÄS
GÄVLE C
FALUN C
KRISTINEHAMN
ÖREBRO C
STOCKHOLM C
NORRKÖPING C
VISBY
37drs
FALKÖPING C
BORÅS C
GÖTEBORG C
NÄSSJÖ
HALMSTAD C
VÄXJÖ
KALMAR C
RONNEBY C
HÄLSINGBORG C
KRISTIANSTAD C
MALMÖ C
tranship. stations

Fig. 2.
(I - 36)

One might expect that in this system in Sweden a relatively great many transhipment points are needed, the number of these, however, is 40. That is why the greater part of the parcels traffic is at most transhipped twice.

The Swedish Administration remarks emphatically that « the classical organization is not applied in Sweden ». This is explained as follows: the receiving area for a certain wagon of category B depends partly upon the amount of traffic (the wagon must be well exploited) and partly upon the train-connections to the station of destination. But,

1) if there are certain regular flows of goods;

2) if there are appointed transhipment points;

3) if the employment of A- and B-wagons to the extent indicated in the Board's transport plan means, that planned regular runnings of A- and B-wagons exist;

4) whereas C-wagons are also employed for less than 2 000 kg to avoid delay of trains and are, moreover, replaced by lorries to an increasing extent;

one may put the question: is there in reality so great a difference with the « classical organization »; is it not a question of an intermediate form and is not the influence of this Swedish organization upon the arrangements of the depots, upon the working methods and the use of handling-facilities similar to the effects of the « classical organization »?

Another variant of the simple « optional runnings » system, very much like the Swedish system and perhaps approaching the « classical organization » even nearer, is the organization of *Soviet Union Railways*.

The wagons for parcels traffic are distinguished in 3 categories:

a) direct wagons — for goods to one destination;

b) transhipment wagons — for goods to various destinations;

c) wagons for collection and distribution at intermediate stations.

Wagons of the categories *a*) and *b*) are called « grouped » wagons. For these wagons the following minimum norms of loading are fixed:

	a) direct	*b*) transhipment
two-axle wagons . . .	7 tons	9 tons
four-axle wagons . .	16 tons	20 tons

On slack routes « defined by the Ministry of Surface Transport » reduced norms of loading for both *a*) and *b*) wagons have been authorized, viz. 5 tons for two-axle and 10 tons for four-axle wagons.

The wagons of category *b*) while under way undergo sorting at freight sorting stations. Apparently contrary to the B-wagons of the *Swedish State Railways* the wagons stop at more than one transhipment station. Because of the sorting of the B-wagons the average speed of progress for the direct wagons is 1 ½-2 times greater than for the transhipment wagons. Wagons of category *c*) are accompanied by weighing and distribution officials. Road Transport is used for parcels traffic between railway stations at large junctions (Moscow, Leningrad).

In 1953, the *Soviet Union Railways* introduced an « Organisational Plan » for « grouped » wagons, which is described as follows: « The Organisational Plan divides each railway network into regions served by corresponding sorting stations. Loads, due for delivery at any given station within the boundaries of a certain region and insufficient for the formation of a direct grouped wagon, may be loaded into a grouped wagon for transhipment together with loads destined for other stations in the same region. In the Organisational Plan there is provision for centralizing the handling of the basic flow of parcels traffic to stated destinations at specific sorting stations equipped for this purpose. Such a concentrated flow of goods at sort-

ing points makes it possible to load a larger number of direct and transhipment wagons for distant destinations, decreasing thereby the amount of work in transit. On the basis of the network plan, regional plans for the organization of grouped wagons are being worked out, regularising the internal flow of parcels traffic carried over both local and main lines. Internal parcels traffic is carried in transhipment wagons and wagons called « cartage delivery » wagons *c*). The districts to be covered by the « cartage-delivery » wagons are arranged in such a way that the goods, having arrived at the sorting station for the network (*), and having as their destination any station within the system (*) may be despatched directly in a « cartage-delivery » wagon, or in a transhipment wagon to a local sorting station for subsequent transfer to a « cartage-delivery » wagon.

The acceptance of goods for transport is organized so as to ensure a maximum number of direct « grouped » wagons, avoid delay at loading points and guarantee the agreed shipment of the goods on a time- and destination basis to the sorting stations of the network. With this in view, parcels traffic is accepted through station warehouses or forwarding agencies in accordance with the calendrical freight timetable authorized by the railway management. This timetable is calculated so as to ensure the despatch from a station of all freight accepted for transportation as parcels traffic, as a rule on the day of acceptance but not later than the day after. The timetable for the acceptance of parcels traffic drawn up for a given station according to dates and destinations is notified to consigners. »

The *Soviet Union Railways* supply some interesting figures concerning the abovementioned decrease of sortings at transhipment stations, which show that after the introduction of the « organisational plan » for « grouped wagons » the amount of sorting has decreased significantly :

	Sortings per consignment
1952	5.2
1954	3.5
1955	2.6

A general impression of the extensiveness of the network on which the parcels traffic (0.3 % of the total freight traffic) is conducted and what has to be performed for this is given by the following figures :

	Number	*% of the total*
overall number of destinations included	4 332	100
with no sortings . . .	489	11.0
with one sorting . . .	1 680	39.0
with two sortings . . .	1 550	36.0
with three sortings . .	500	11.5
with four sortings . . .	113	2.5
average number of km run without sorting	540	—

The system of the *Indian Railways* shows a strong resemblance with the systems of the Swedish State Railways and the Soviet Union Railways. This system seems a little more complicated than the abovementioned other two (see below *b* 1) but this is only a matter of relabelling and redirecting wagons. Reporter is inclined to think that the optional character of this system is somewhat more accentuated by the higher prescribed minimum weights and severer regulations for sticking to these minimums. Viz. : the minimum weight limit for the preparation of all various types of wagons is generally 250 mds (9.2 tons) for broad gauge, 160 mds (5.9 tons) for metre gauge, 100 mds (3.7 tons) for narrow gauge sections. Optional runnings of wagons is not permitted unless the prescribed minimum weights are reached.

The system in the wording of the *Indian Railways* themselves (with the exception of the indications *a*), *b* 1), *b* 2) and *c*) runs as follows :

(*) In reporter's opinion this should be read : region.

to eliminate to the maximum extent feasible handling en route, obtain fastest possible transit by goods trains and also economic loads for wagons used, smalls are despatched by forming, in the order of preference shown below, the following types of vans :

a) *Through Sealed Van :* All traffic in smalls for a particular destination is collected, if necessary, over a period of two or three days, and is loaded in the same wagon which is sealed direct to the destination;

b 1) *Sectional Sealed Van :* If adequate load for a single destination is not forthcoming, traffic for a number of stations on a distant section is loaded in a wagon which is sealed to the « Engine Changing Station » serving the section. On arrival at the « Engine Changing Station », these vans are attached to the Van Goods Trains and become Collecting or Section Road Vans (see *c*) for the sections concerned. Such vans do not contain packages for the commencing stations of these sections;

b 2) *Junction Sealed Van :* Failing the feasibility of forming either of the abovementioned two types of vans, all traffic routed via a « Repacking shed » or a « Break-of-Gauge Transhipment shed », for all the sections served by these sheds is loaded in a wagon and sealed to the shed where it is repacked or transhipped in suitable vans for onward despatch to destination;

c) *Collecting Road Van :* Traffic which cannot be cleared by any of the above means, is despatched in a Collecting Road Van in charge of the van sorter/guard, each of these vans containing consignments destined for particular sections · These vans are attached to Goods Van Trains which run to fixed schedules.

4. Forwarding.

3. — *What principles have been adopted for the forwarding and marking of parcels?*
— *Do you use journey labels?*
— *What amount of clerical work is required during the transport?*

Forwarding and everything in connection with this only being of importance for this study on account of its significance for the work in the depots, the division mentioned below is considered the best :

a) acceptance for transportation;

b) indication of route of goods and documents;

c) « confrontation » of goods and documents during the transport.

Ad a).

« Entrance ticket » for the goods is the *consignment-note* filled out by the consigner. Some Administrations use the name « way bill ». Distinction between « consignment-note » and « way bill » is conceivable and is to reporter's knowledge, sometimes made, especially where no multiple consignment-notes are used and separate documents are made out at the railway offices from the particulars of the consignment-note.

It may be supposed that the particulars to be given on the consignment-note by the consigner vary little at the various Administrations. The usual data are : address, number of packages, nature of goods, nature of packing, marks or numbers of packages, weight of consignment, particulars (e.g. inflammability, fragility, requested way of loading and unloading). The *Soviet Union Railways* demand still another datum on the consignment-note, which cannot be supplied by consigner but is filled out and signed on the consignment-note by the stationmaster, his deputy or the goods office supervisor viz., an entry permit (*). Herein is indicated : the time

(*) Literal translation from Russian : a visa for « bringing in ».

of presentation of the goods, the date of loading and the number of the depot or region to which the goods are to be conveyed. Not later than twenty-four hours before the presentation of the goods for shipment the way bill must be presented at the goods-office in order to obtain the visa.

The administrative dealing of the consignment-note is beyond our subject. It is mostly done *after* checking in the shed by the checker. Worth mentioning, however, is the *preceding* detailed registration by the *British Railways,* which at large depots is done by *microfilm.* This has connection with the method of checking and wagon loading. Goods tendered by consigners or brought in by the pick-up service are loaded on — often horse drawn — cartage vehicles. Consignment-notes after registration are endorsed with instructions and then passed on to the checking staff responsible for discharge of the cartage-vehicles straight into the wagons. Quick registration is in this case of great importance.

As regards the labelling of the *goods* by the consigner the instructions of the Administrations vary little. Accurate addressing, conform the way bill naturally is a general instruction; also a detailed address of consigner. Often an indication of the nature of the goods (inflammableness, fragility) is required as well and sometimes marks, numbers and weight (gross and net) of the packages, together with the name or the indication in code of the despatching and receiving stations (*South African Railways, Soviet Union Railways*). Most detailed in this respect are the *Soviet Union Railways.* Sometimes the design of the address-labels is drawn up by the railway, as is the case with the *Norwegian State Railways,* which also allow markings with durable and conspicuous colours directly on the packages.

The Administrations state little about the *checking* of the goods against the consignment-notes. It may be presumed that this checking — comparing the addresses, counting, weighing, measuring of packages and, if necessary, verifying if the necessary data re nature of the goods and way of handling have been recorded — is executed fairly alike. The subsidiary company of the Netherlands Railways, N.V. Algemene Transport- en Expeditie Onderneming Van Gend & Loos does this checking as a rule at fixed places in the goods shed at the roadside where bascules are let into the shed floor. Goods of important regular consigners, whom there are often agreements with, concerning flat rates, « self labelling » (attaching of journey-labels by consigners themselves) and palletizations are often only counted.

The checkers as a rule do little clerical work, of the kind to be mentioned in this paragraph. They are often involved in the work ad *b*). At the *Soviet Union Railways,* at acceptance, the checker does the following clerical work besides : verification of the entry permit (« bringing in » visa) and writing and issuing of a certificate of acceptance against the consignment-note, which thereafter is transmitted to the goods-office.

In the cases that labels stating the nature of the goods (*Swedish State Railways*) and way of handling are prescribed and need not be stuck or attached by consigners, this is also done by the checker or his assistant.

Ad b).

The *route-indication* of goods and documents by the various Administrations varies widely from a few written code characters on waybill and packages to detailled stamping or code-writing on documents and special labelling on the packages.

Ad c).

The Administrations who have answered the question report that little or no clerical work is done during the transport. But at the railways who report that checking finds place only at transhipment or only in some cases of transhipment (*British, East African, Eireann, Soviet Union, New Zealand Government Railways*), at any rate « *confrontation* » *of previously made*

Administration	*Document*	*Packages*	*Transit doc.*
British Railways . . .	coded instr. endorsed on cons. note	not marked	none, except as regards « vulnerable » (manufactured tobacco, textiles, wines, spirits) and sea-borne parcels.
East African Railways	consignment note with serial number by which identity of consignment is determined, one copy of « Goods Invoice », prepared from original copy of cons. note accompanies consignment to ultimate destination	marked with three letter code of forw. station + last three fig. of serial number of cons. note + three letter code of station of destination; e.g. NRB cons. 24789 789/3 3 packages MSA from Nairobi to Mombasa	tally-records compiled at loading and discharging at forw., transh. and dest. station.
Eireann Railways . .	cons. note	no journey labels	cons. note
Indian Railways . .	cons. note vehicle guidance furnishing booking particulars of cons. loaded in wagon and placed inside wagon; copy of v.g. is sent to dest. station, repacking or transh. shed or given to van sorter/guard	marked with code initials of forwarding and receiving stations, the last three digits of the consignment note or invoice number and the number of packages, thus CCB $\frac{345}{50}$ DL 1, CCB = forwarding station 345 = last three digits of cons. note 50 = number of packages DL 1 = receiving station	vehicle guidance
Netherlands Railways.	cons. note with serial number date stamp destination station name of group head station of destination group is written on cons. note by checker	journey labels (fig. 3)	
New Zealand Government Railways . .	cons. note abbreviations of station names (« Station Brands »)	no journey labels sometimes « Station Brands »	cons. note
Soviet Union Railways	cons. note journey schedule	official railway label (ensuring that freight corresponds with forw. documents and establishing appurtenance of goods to a definite consignment)	journey schedule wagon list

out documents (wagon lists, consignment notes, waybills) with the goods will have to take place. Tally-records need not be among these documents, but most profit is made of tallying on the forwarding station if the record is used as check-document at the transhipment station as well.

Fig. 3.
(I - 4 ad b)

The necessary documents will have to be sent together with the goods or forwarded ahead by mail- and passenger trains. The *Netherlands Railways,* who do not apply checking at transhipment but only at the transfer of the consignments from the depot to the delivery-service, forward the consignment-notes in many cases by late passenger-trains and night mail-trains.

At the *Indian Railways* a certain amount of clerical work during actual transport is done by the van sorters/guards in the « Collecting Road vans » (see p. 246/16), who are required to record in the vehicle guidance concerned the details of loading and unloading at stations en route into and from the wagons in their charge, and they are also required to prepare a vehicle guidance for the wagons which they might repack and seal to a station during the run. At the transhipment or repacking stations also particulars of unloading or reloading are required to be recorded.

5. Type of wagons.

4. — *Is the parcels traffic transported in wagons specially designed for this traffic? If so, please give the characteristics of these wagons. If not, are certain types of wagons used when possible? For what reasons?*

Only the *Association of American Railroads* and the *Netherlands Railways* report that specially designed wagons are used for parcels traffic. In the U.S.A. some railroads have assigned certain types of covered wagons to handle parcels traffic on their own lines. One Administration has assigned several hundreds of covered wagons for local service and these wagons are specially equipped. The *Netherlands Railways* use special parcels wagons, all covered wagons of one type (fig. 4). The characteristics of these wagons are:

— number of axles: 2;

— distance between axles: 6 m;

— length (buffers included): 10.67 m;

— average own weight: 11.9 t;

— load-capacity:

A	B	C
20	21	

— loading-space floor: 25.6 sq. m;

— capacity: 57.3 cub. m;

— inside measurements:
length: 9.4 m; width: 2.7 m;

height of sidewall: 2.0 m; height of doorway : 2.0 m; width : 2.0 m;
- speed mark : S;
- loading-panel at either side for loading extraordinary long packages;
- reinforced floor for the use of forklifttrucks;
- at the corners of the wagon there are yellow bands on all four sides.

When 2 or 3 trains of these wagons stand alongside the goods shed (older type) aside of each other, the doors of the sheds and of the wagons face each other; if necessary, stationary lamps fixed to the shed and reaching over the tracks illuminate the doorways. When the wagons stand in the sheds (new type), the stationary illumination is fixed just in front of the doorways. Signboards, indicating stations or destinations always hang in the correct place, near the doorways of the wagons.

The « cartage-delivery » wagons used by the *Soviet Union Railways,* for collection and distribution at intermediate stations (see par. 2) are also of a special type. They are derived of normal four-axle freight wagons and incorporate a service-compartment of 3.5 × 2.7 m, for the four men gang of checkers and freightmen, which is isolated from the freight-space by a fixed partition with an observation window, thus resembling a luggage- and guards-van.

The type of wagons used for the transport of containers is not described. The other reporting Administrations have no specially designed wagons for parcels traffic. From the different types of open and covered wagons on hand they always try to choose the most suitable type and size for the traffic tendered.

Fig. 4.
Netherlands Railways. Standard parcels wagon GW : « group wagon » (I - 5).

* * *

The *administration* of parcels traffic is not part of our subject. But just as a right-minded railwayman likes to cross country-borders, your reporter would like

to look over the borders of his subject. He cannot resist the temptation to make some remarks about the administration of parcels traffic. Parcels traffic implies an extensive administration. Without a properly organized administration parcels traffic business is inconceivable. As a not unimportant part of the services offered to the customer is carried out in the goods offices, in the battle against road competition the increase of efficiency of the administration is imperative; it is even imaginable that by an efficient administration a lead over road competition may be gained. And, to maintain some connection with our subject, an efficient administration may considerably further a smooth working — process in the depots and in the collection — and delivery-service.

Probably not on account of road-competition but on account of an endeavour to contribute to an increase of the national productivity, the *Soviet Union Railways,* as may be gathered from their reports, have paid a great deal of attention to the furtherance of the productivity of their parcels traffic administration. Their activities have had the effect that « the time taken for each phase of documentation is regulated by a technological process of work for a given goods station, calculated on the basis of work carried out at a typical station and confirmed by the Ministry of Surface Transport ». The result has been that « with this system the number of documents completed per unit of time has been significantly increased ». The *Netherlands Railways* subsidiary company Van Gend & Loos have followed a similar working-method. By means of systematic process-analysis and time-study has been achieved that in the years following the second World War a great increase of traffic could be attended by a decrease of staff in the goods offices. Identical results are not reported by other Administrations but it must be presumed that these have been reached there as well.

CHAPTER II.

THE GOODS DEPOTS.

5. — *What arrangements have you adopted in your goods depots in order to facilitate the services, sorting, handling and getting parcels ready:*
— a) *for the outgoing sheds (road to rail);*
— b) *for the incoming sheds (rail to road);*
— c) *for the tranship sheds (rail to rail).*

Are all these sheds grouped together in a single unit?

Please include diagrams of the principles on which the work is laid out, or of installations considered the most up to date, showing the volume of traffic handled daily in each of these departments.

It appears that in the answers the denominations « depot » and « shed » have sometimes become mixed. Reporter regrets that the relating questions in the questionnaire have given rise to this confusion. By « depot » reporter understands the entire premises with buildings (sheds, warehouses, offices), platforms, railway tracks, roads and tracks for road vehicles and internal cartage vehicles, line-up area for the vehicles of the pick-up and delivery service, for clients' vehicles, etc.

A. Location of the depots.

The locations of old depots were defined by factors which for us now are merely « coincidental » or « historical ». The locations of new depots or of those yet to be built are generally defined by « town-planning » or « regional planning », in which many interests a.o. those of the Railway Administration play their part. The most favourable location for the present management is hereby seldom reached. This most favourable location is the point of equilibrium of the « fac-

tors of location », which count for the total management; hence this need not be in the centre of the area to be covered.

For a combination of incoming and outgoing depot another location might be more favourable, e.g. if shop-, factory- and residential districts lie apart and if there is a considerable difference in the amount of incoming and outgoing traffic. It is even possible that, if in a town the density (in number) of the consigners does not correspond with that of the receivers for the various districts, separate locations for outgoing and incoming depots are efficient.

In existing situations separate locations of depots is sometimes an intentional adaption to the function, sometimes more or less coincidental factors are the cause of the specialization (e.g. fusion of railway companies and either of the depots being too small for the combined function.) Four Administrations have reported something about specialization of depots.

At the *British Railways* only one depot is devoted entirely to tranship traffic. The *Swedish State Railways* have 3 special transhipment depots, at Hallsberg, Nässjö and Ånge (see map, fig. 2, and ground plans of the depots, App. 1). The *Soviet Union Railways* have several special transhipment stations, called « sorting » station. The *Netherlands Railways* have an incoming and an outgoing depot at different places at The Hague.

B. Lay-out of the depots.

6. — *Please give the essential characteristics of your installations :*

— *Necessary area in relation to the tonnage handled for each of the above sheds;*

— *Length and width of the platforms. Do you prefer short, wide platforms or long narrow ones? Why?*

1. *Type of depot.*

The depots can be divided in *sectional* depots and *combined* depots. Sectional depots have separate platforms, railway-tracks, cartage roads, line-up areas for road vehicles, and other establishments — among which sometimes offices — for handling incoming, outgoing, respectively transit goods. The lay-outs of these depots vary too widely as to enable to supply a short general description. This could be a subject for a separate extensive study. This even might be the case with the so much simpler combined depots. In these depots the same establishments and arrangements are used for the handling of incoming, outgoing and transit goods. Mostly alternately, seldom at the same time, such in contradistinction with the arrangements of the sectional depots. If in a combined depot different handlings regularly take place simultaneously, then these generally are handlings of incoming and of transit goods or handling of outgoing and of transit goods. If in a combined depot the handling of outgoing and incoming goods takes place simultaneously, then this depot is only a combined depot in appearance, provided such handling takes place regularly, unless this occurs during short overlapping periods or in a chaos.

Sectional depots are necessary in places where the handling of outgoing-, transit- and incoming goods, collection and delivery included, cannot be realized in free succession. Where free succession is not possible but the time during which the handlings overlap is short or the volume of the goods flowing in opposite directions is small, a combined depot will still be of practical use. In cases that a 24-hours cycle is possible, the combined depot offers the advantage of intensive use of space, installations and handling facilities, of which the first is only necessary for handling. Sectional depots, which are in full operation night and day, must have the disposal of large spaces for storage (the rolling stock of p. and d. serv-

ices included); there are always goods in the depot. A characteristic of a properly operated combined depot is, that twice in 24 hours it is empty for a certain, generally short lapse of time. This presents the psychological advantage that in the course of operations the « clean depot » becomes a fixed goal to aim at. An advantage of sectional depots is that these can be more adapted to their function, hence allow more adapted working methods.

We have to restrict ourselves to these few superficial remarks; about depots a theoretical book might well be written (in the line of: « Principles of parcels traffic depot arrangement »). The every day's practice is more interesting; to describe it is our task.

Very interesting examples of typical *sectional depots* are to be found at the *British Railways* where separate outgoing and incoming accommodations are provided wherever practicable, preferably under one roof. The outgoing and incoming accommodations differ widely, as may be seen from annexed diagrams (appendix 2). These are adapted to the British Railways' modern policy of dealing with the traffic in the following manners:

in outgoing (or « forwarded ») sheds:

— load traffic direct from road vehicles to wagons (50 % of the forwarded parcels traffic is already dealt with in this manner);

in incoming (or « received ») sheds:

— unload by conveyors and/or movement in bulk on power trucks, stillages or internal cartage units;

in tranship sheds:

— unload (and load) as in incoming sheds.

Performance:

Diagram	*Received traffic (including tranships)*			*Forwarded traffic (including tranships)*		
	Traffic dealt with per 8 hours	Area per ton handled		Traffic dealt with per 8 hours	Area per ton handled	
		sq.ft.	m^2		sq.ft.	m^2
20/1	up to 150 tons	235	21.3	up to 200 tons	270	25.1
20/2	up to 320 tons	280	25.4	up to 400 tons	230	21.4
20/4	up to 200 tons	356	32.3	up to 400 tons	242	22.5

Note. — Where longer hours are worked tonnages increase and areas per ton handled decrease proportionately.

Reporter draws attention to the fact that descriptions or diagrams of the accommodation considered most up to date were asked for. The aforementioned description of British modern depots therefore does not imply that these are to be found everywhere at the British Railways.

Reporter states this because the *Swedish State Railways* as it were apologize for their sending in the diagram of a

new medium-sized depot, viz., the Hälsingborg depot, with the remark that the larger Swedish goods depots are old and the modernization that has been realised had to take place within the frame allowed by the original design, so that no description could be supplied of a large depot designed and built throughout according to the modern principles and rational working methods now known. This situation has probably arisen at most Administrations.

The Hälsingborg depot of the Swedish State Railways (see appendix 3) is a much simpler type of sectional depot than the above-mentioned British depots. This is a shed, which is simply divided into an incoming and an outgoing section by a wall with doorways. This shed can easily be transformed into a combined shed if need be. Besides, there are platforms mainly in the length of the shed, which are to a great extent of the character of transhipment platforms. The situation of the saw-shaped platforms and of the railway tracks in front of the shed indicate specialization in incoming and outgoing goods but the use of these in turns in two directions is possible without much difficulty, though the transport distances become longer. The whole gives the impression to be arranged as a sectional depot, rather because much space for storage and delivery is necessary for the received goods than because the handling at forwarding and receipt demands such.

Grounds for this conclusion are :

1) the length of the incoming shed is 1 1/2 x the length of the outgoing shed, whereas the quantities of incoming and outgoing goods are about the same (approx. 45 and 50 tons per day);
2) Hälsingborg is not a small depot, so it is likely to be served chiefly by A- and B-wagons, which are usually hauled in fast night-trains, so that the goods arrive early in the morning and are despatched in the evening;
3) in Sweden the consignees frequently collect the goods themselves, so that delivery is not entirely in the hands of the Railway Administration;
4) 1 200 sq. m (the platforms outside the shed not included) only for the handling of 45 tons of incoming goods a day would be a rather great space (compare the « received sheds » of the B.R. and combined sheds of the Netherlands Railways). With the latter, however, it should be kept in mind that the shed is new and is therefore probably calculated for future wants. Approx. 35 tons of goods are transhipped daily, the transhipment is carried out chiefly on the platforms. The number of incoming wagons is approx. 30 a day, so is the number of outgoing wagons. 50 + 35 tons and 45 + 35 tons in 30 + 30 wagons a day indicates that the regulations for the loading of A- and B-wagons (comp. chap. I, par. 3 *b*) are properly observed.

The *Soviet Union Railways* are developing the use of containers in parcels traffic handling and transport in every possible way. Almost half the parcels traffic which passes through the depots is transported in containers. For the benefit of this special *container depots* have been developed and built on a large scale, a profile drawing of which is shown (fig. 5). In consequence of this no new types of depots and of goodssheds for the more common method of handling parcels traffic have been developed and the old not standardized sheds are merely adapted to the mechanization of the work. New sheds of the traditional type have been built; these are standardized (fig. 6). These and the old sheds are the main element of sectional depots. They are divided into incoming and outgoing sections, separated by walls, which nowadays are mostly fitted with doorways for the mechanized shed vehicles. The handling of parcels traffic in transit takes place on special covered platforms (fig. 7) which are to be found mainly at the

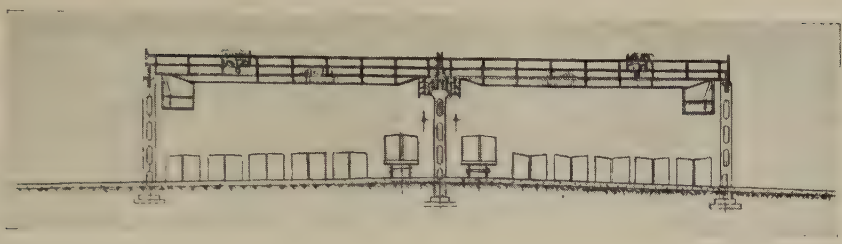


Fig. 5.
Soviet Union Railways. Standard shed of traditional type (II - B - 1).

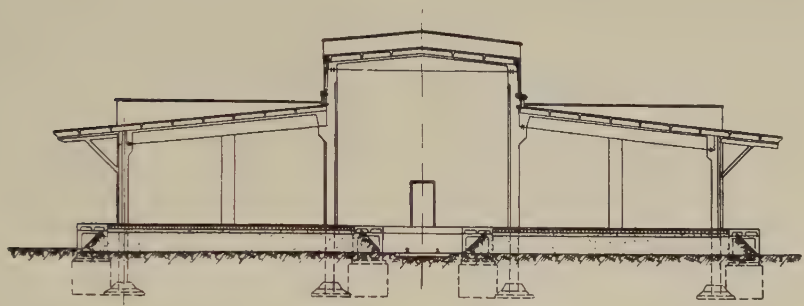


Fig. 6.
Soviet Union Railways. Standard shed of traditional type (II - B - 1).

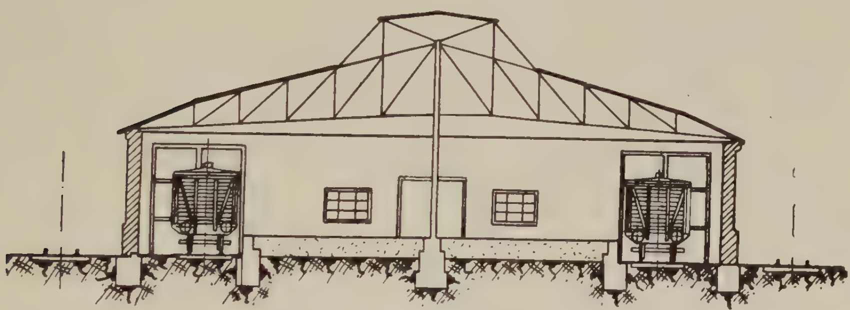


Fig. 7.
Soviet Union Railways. Transhipment shed (II - B - 1).

regional stations and sorting stations (see Chap. I, par. 3 *b*) of which some are sectional depots, some special transhipment depots.

Large depots handle upward of 2 000 tons of parcels traffic in 24 hours. The greater part being handled in containers, the turnover through normal sheds does not exceed 600-800 tons in 24 hours, not even in the largest depots.

The *Indian Railways* have combined depots at smaller stations. The large

depots are typical sectional depots sometimes specialization within the divisions is carried on further (see appendix 4). The outgoing, incoming and « repacking » and transhipment sheds are normally located and grouped together in the same area. The incoming as well as the outgoing sectors of the large depots as a rule consist of more than one shed. These sheds are sometimes specialized again according to *sorts of goods* (dangerous goods, perishables, oil, paints, textiles, grain, general merchandise) according to *kinds of parcels traffic* (traffic by passenger and special trains, miscellaneous « smalls », general merchandise) and according to *way of dispatch* of the goods (long distance traffic). The specialization first mentioned points to storage of longer duration and the different adherent demands for the diverse kinds of goods at which the climate undoubtedly plays an important role. This specialization, however, also gives the impression that the large sectional depots are not only depots for parcels traffic but for car load traffic as well.

The *South African Railways* have sectional depots with incoming and outgoing sheds and transhipment platforms at the larger centres. At the smaller stations all sheds are usually grouped into a single unit under one roof.

The *New Zealand Government Railways* have sectional depots at the four main cities, with separate incoming and outgoing sheds. At other places incoming, outgoing and transhipment work is carried out in one shed. From the latter reporter understands that combined depots are indicated here.

The *Eireann Railways* and the *Malayan Railway* have as a rule grouped their sheds into a single unit. They do not report if these sheds form a sectional or a combined depot.

The more important depots of the *Norwegian State Railways* are sectional depots with special incoming, outgoing and transhipment sheds, whereas at the big despatching stations the goods for certain points and lines are loaded directly into the wagons (comp. British Railways).

The *American Railroads* usually have sectional depots. In major cities the older depots were usually constructed with separate incoming and outgoing sheds. If such depots were also transhipment depots the wagons with transit goods were placed on intermediate tracks. In recent years, due to the decline in traffic tonnage, some American Railroads have abandoned either the incoming or the outgoing shed and now use one end of the remaining shed for outgoing traffic and the other end for incoming traffic.

At the *Netherlands Railways* the prevailing type of depot is the combined depot. Only the largest depots — at Amsterdam, Rotterdam and Groningen — are sectional depots, with one shed (at Amsterdam and Rotterdam without partition walls) but with different arrangements of the shed sections for incoming and outgoing traffic. At Amsterdam and Rotterdam there is no transhipment of traffic from rail to rail. At Groningen transhipment from rail to rail is carried out in the incoming and outgoing sections of the shed; in the evening in the outgoing section, at night and in the early morning in the incoming section. (Appendix 5).

2. Handling floor.

a) Type of handling floor.

7. — *How are the wagons and lorries loaded and unloaded :*
   — *from approximately floor level? (platforms);*
   — *from ground level? (yards);*
   or do you prefer mixed solutions?
   What are the reasons for your choice?
   What platform height have you adopted (rail side and road side) and what arrangements have you

made to carry out handling operations in view of possible differences in level?

In the depots of all reporting Administrations the *handling floor* for incoming traffic is a platform. The height of this above rail top and road level is sometimes the same, mostly different. At most Administrations the handling floor for outgoing traffic is a platform too. This is considered the most economical arrangement, because then no vertical transport need take place while loading and unloading wagons and road vehicles (at any rate need not be done by the railway). The *British Railways* prefer mixed arrangements of platforms in « received » sheds and cartage units in « forwarded » sheds (see appendix 2), the floor levels of the cartage units being approximately equal to those of the outward wagons. This Administration's experience shows that this solution is the most economic. The *New Zealand Government Railways* usually adopt the mixed arrangement of « partly shed and partly yard ». In the yards traffic is then handled from ground level, but usually direct from lorry to wagon. Most *Indian Railways'* important depots are provided with high level platforms, generally of the same height as the wagon floor. Loading boards are used for loading from rail level. The difference in level does not present any serious difficulty, except that loading from or unloading on lower platforms necessarily consumes more manual labour (mostly wagons, trucks and carts are loaded and unloaded by porters, carrying the packages on their backs). The Administrations making use of platforms for incoming and outgoing handling in special cases apply loading from ground level or from lorry and unloading on lorry. This is mostly done with very heavy and/or voluminous goods, which are handled in the yard in this way, sometimes at special places where stationary cranes are placed, sometimes with the aid of mobile cranes or heavy forklift trucks. This is seldom done at the *Netherlands Railways.* It is the usual procedure at the *Soviet Union Railways* in the special depots for the handling of parcels traffic containers (see fig. 5).

The usual heights of the platforms are :

	above rail top	*above road level*
British Railways	3'6" to 3'8" (1.07 to 1.12 m)	3'3" to 3'7" (0.99 to 1.09 m)
East African Railways. .	2'10" (0.86 m)	?
Indian Railways.	(broad gauge rlw. 3'6" (1.07 m) (metre gauge rlw. 2'3" (0.68 m) (narrow gauge rlw. 2'0" (0.61 m)	?
Netherlands Railways . .	1.23 m	1.10 to 1.15 m
New Zealand Govt. Railw.	2'8" (0.81 m)	?
Norwegian State Railways	1.18 m	1.10 m
Soviet Union Railways. .	1.10 m	1.10 m
Swedish State Railways.	1.20 m	1.25 to 1.35 m

Where there are differences in level between platforms and wagons or road vehicles, all Administrations make use of loading plates, loading boards, bridge plates, used as ramps, sometimes of special construction, so that these have almost become gangways or movable bridges.

Having procured in 1957 some hundreds of 1 1/2 tons delivery vehicles with a floor-height of 76 cm, the subsidiary company of the *Netherlands Railways* now have to employ a special means to eliminate the difference in level between shed deck and vehicle floor in order to avoid the use of long bridges. This is a temporary solution till an opportunity is found to raise the cartage road. This means consists of bevelled sleepers fitted with ribbed steel plates which lie stationary in the road or are fixed to the shed wall if there is no railway track on the roadside. In places where a railway track runs alongside the shed these sleepers lie loose on the road or are fixed to the shedwall in such a way that they can be shifted flat against the wall. When the delivery vans stand on these blocks they slant forwards. To prevent collision with the loading platform chocks are fixed to the sleepers. (Appendix 6).

b) Shape, required area and division of the handling floor.

8. — *If the installation includes several platforms, how are these linked together (facing platform, moveable bridges, lifts, etc.). What are the advantages and drawbacks of these different systems?*

   Do you allow a platform to be served by a track which does not adjoin it, by passing between wagons on the adjacent track?

   If so, what arrangements and precautions are taken to make sure this operation is carried out correctly?

9. — *What space is reserved for delivery to door services?*
   - *number and shape of the bays;*
   - *storage available relatively to the daily tonnage handled;*
   - *area of clear space required for trucking to the delivery vehicles.*

10. — *What sites are reserved for the delivery stations?*
   - *arrangement of the bays;*
   - *storage available relatively to the daily tonnage received.*

   State if there are certain facilities for stacking the goods such as radial storage, staging, etc...

From the answers of the Administrations reporter has only been able to distil a few general lines concerning the shape, the area required and the division of the handling floor. He does think, however, to have been able to derive the following defining factors for the shape, the area required and the division :

- the amount of goods to be handled;
- the ratio in amounts of incoming, outgoing and transhipment goods;
- the number of destinations;
- the number of delivery zones;
- the working method;
- the endeavours to acquire short transport distances;
- the dispatch system;
- uniformity or multifariousness of wagons;
- the existence or non-existence of own pick-up and delivery services.

None of these factors is entirely independent of the others (thus the endeavours to acquire short transport distances and the working method closely cohere; in the same manner there is a coherence between amount of goods, number of destinations and dispatch system) and it may be possible to reduce them to a few general

factors (among which the general one often brought on the stage in « explanations »: the structure and the phase of development of the national economy).

Neither can all be of influence independently (e.g. the quantity of goods). But further analysis does not fit within the scope of this descriptive report. Reporter need not have derived said defining factors from the answers, he would have been able to find these, and presumably others, also along the lines of deduction, but he has restricted himself to the factors either mentioned in the answers or obviously involved in the considerations.

A short contemplation of the influences of the defining factors and the complexity of their coherence may precede the mention of the Administration's replies. It seems to be clear that the required space of the handling floor is primarily defined by the amount of goods.

This datum defines nothing, however, without some other datum : e. g. the number of destinations. In this respect it is understandable that the *Swedish State Railways* (who of all Administrations in their answers pay most attention to questions of this kind) starting from the fact that there is naturally always an amount of goods, remark : « the area in the outgoing sheds depends upon the number of destinations ». The thought is : a certain amount of goods in a depot with few destinations (or delivery zones) can be handled on a much smaller area than in a depot with many destinations or delivery zones as in the former case contrary to the latter little or no sorting area is needed. The Swedish State Railways consequently proceed : « when there are only a few outgoing vans the goods can as a rule be driven direct from the receiving entrance to the railway-van, and in this case there is no need for storage space for the goods. If, on the other hand, the goods are to be distributed among several vans, space will be needed for the sorting of the goods near the receiving gates. Since, however, the number of outgoing vans is related to the quantity of goods, the area that will be required per ton of goods will be, on the whole, the same in the bigger and medium-sized sheds, though deviations may sometimes arise on account of local conditions ». Apparently the Swedish State Railways assimilate « vans » with « destinations ». It is, however, imaginable — also with the Swedish dispatch system — that there are few destinations and many vans, viz. when there are many goods per destination. This might for instance be the case in a small, not densely populated, but extremely urbanized country. In that case it may be very efficient that little sorting and much direct transport from road-side doors to wagons take place. Perhaps some concessions will have to be made as regards the endeavours towards short transport distances (at least as regards little transport per ton of goods), but the working method will possibly render this concession attractive (by mechanization of the transport instead of costly manual labour for sorting). The Swedish State Railways justly remark that a relation exists between the number of outgoing vans and the quantity of goods, but such a relation also exists between the number of outgoing vans and the number of destinations and also between the number of destinations and the quantity of goods (this last is certainly true with the Swedish dispatch system which offers the possibility of direct wagons for a certain minimum tender of traffic). This can be looked upon as a — fully legitimate — « triangle affair ». But then it cannot be simply put that « the area that will be required per ton of goods will be, on the whole, the same in the bigger and the medium-sized sheds ». Naturally the Swedish State Railways primarily have in thought their own circumstances and by way of precaution they add : « though deviations may sometimes arise on account of local conditions ». It may be assumed, however, that the « local conditions » above all things consist in the number of destinations to be served.

The « triangle relation » is of a varying

character depending on the dispatch system. With the classical organization the relation between the quantity of goods and the number of destinations is much less close than with a system of optional runnings, on the other hand, the relation between the number of wagons and the number of destinations is a great deal closer with the classical organization than with an organization with optional runnings. This is finally expressed in a different need of floorspace per ton of goods. It is conceivable that with the classical organization more surface space per ton of goods is needed than with other organizations. In this connection, however, matters are complicated by the fact that with the classical organization *1*. there is a greater flow of goods because there is no need for waiting and consequently goods need not be stored until the minimum quantity for a direct wagon is available, *2*. a stricter working-method can be maintained (there are always the same destinations, the wagons always stand in the same place).

A faster and better controllable flow of goods is obtained at arrival when there is an own delivery service available. There is no need for storage while waiting for the consignees' collecting the goods.

It is clear from the above that the quantity of goods to be handled cannot be said to be the principal defining factor for the floorspace required. It can be said, however, that the main influence of the quantity of goods finally concerns the necessary floor-space.

In coherence with the number of destinations and delivery districts the amount of goods is also defining for the design and in coherence with the ratio of the amounts of outgoing, incoming and transhipment goods for the division as well (in particular in combined and quasi-combined depots) and owing to that again for the design.

Here once again we find a combination of defining factors which are complementary as well as counteracting. For instance : a great number of destinations can in itself cause a tendency in design towards a long platform (sheddeck or otherwise) or to a series of short platforms aside of each other. In a combined depot a great number of delivery districts can emphasize the tendency towards a long sheddeck; the endeavours towards short transport distances can counteract this tendency and strengthen the tendency towards a series of short platforms aside of each other. If the number of platforms required is great, it may then be possible to have these combined with a great many bays for the delivery districts by placing these on a deck which runs at right angles with the platforms (grid type). If this solution is not possible and if the deck must run parallel with the platforms, then the endeavours towards short transport-distances may tend towards island type platforms. These, however, cause difficulties in the shape of interconnecting bridges and passage through the wagons. Bridges may hamper marshalling between times, passage through the wagons likewise. The latter renders marshalling particularly difficult, when there is no uniformity of dimensions of wagons, as it makes very accurate marshalling necessary (see *Swedish State Railways'* reply to question 8).

With such a multiplicity of defining factors and the complementary or counteracting influences emanating therefrom, it is clear that a proper planning when building or altering depots in very difficult. When designing important depots it will therefore be necessary, if we are not already tied by too many data, to call in the modern planning technique of « linear programming » to approach an optional solution as much as possible.

The concrete data supplied by the Administrations are on the whole too scarce and too diverse to supply anything more than a very careful general description of the evoked picture.

This description is :

	small depots	large depots		
		incoming	*outgoing*	*tranship*
Shed	long, narrow	long	short, broad	long
Indoor platforms		long	short, narrow	long
Outdoor platforms . . .		long	short, narrow	long
Area required per ton .	moderate	large	small shed : large	large

Fig. 8.
Swedish State Railways. Bridge-wagon (II - B - 2 b).

The concrete data relating to this chapter, supplied by the Administrations, follow hereafter :

Administration.	*Area per ton handled.*
American Railroads	The patform area is governed entirely by the volume of ton handled.
British Railways	See diagrams appendix 2. *Received traffic* diagr. / traffic dealt with per 8 hours / area per ton handled 20/1 up to 150 t. 235 sq. ft. = 21. 20/2 up to 320 t. 280 sq. ft. = 25. 20/4 up to 200 t. 356 sq. ft. = 32. *Forwarded traffic* diagr. / traffic dealt with per 8 hours / area per ton handled 20/1 up to 200 t. 270 sq. ft. = 25. 20/2 up to 400 t. 230 sq. ft. = 21. 20/4 up to 400 t. 242 sq. ft. = 22.
East African Railways	Incoming platforms : 1 sq. ft. (0,093 m²) to 3 tons of t per annum (rough approximation).
Eireann Railways	No fixed ratio.
Indian Railways	Incoming shed : accommodation approx. 3 times the floor of the daily average number of incoming wagons.
Malayan Railway	No fixed formula.
Netherlands Railways	20 m².
New Zealand Government Railways	
Norwegian State Railways	
South African Railways	A general rule cannot be laid down.
Soviet Union Railways	Taking into account the length of storage-time a) loose packages . . . . 4 *b*) containers . . . . 3 *c*) very heavy goods 2
Swedish State Railways	Outgoing sheds . . . . 1 Incoming sheds . . . . Transhipment sheds . . . .

Length and width of platforms; preference.	Observations.
the outbound platform is narrower than the inbound; depends upon volume of traffic. power truck working is necessary on platforms : rrow and short as practicable.	(Ass. of Am. Railroads has misunderstood the question regarding area per ton handled; question was not clearly formulated owing to a faulty translation of the original French text; rep.) In *incoming sheds* where conveyor working is adopted, platforms are virtually eliminated (diagrams app. 2). In *outgoing sheds* apart from a small platform for sorting purposes (diagram app. 2*a*) no platforms are considered necessary.
idth for outgoing and incoming platforms is 40 ft (12 m); dependent on the amount of traffic dealt with expressed ber of wagon units to be placed.	In the absence of a railway operated delivery service traffic is retained in shed for an average of two days until collected by consignees.
ndard dimensions; preference for long platforms, because : ls can be placed conveniently for outloading and delivery; on vehicles can place parcels on platform opposite wagons loading, and conveyance from wagons to delivery berths to a minimum; *2* shunting is kept to a minimum.	
ms lengths to be adequate for the aggregate length of total r of wagons to be handled at one time; wide platforms ferred at outgoing, incoming and « repacking » stations, onvenient for stacking of goods and for checking, sorting repacking » narrow platforms are preferred at breake points where the process is mainly of transhipment ne wagon to another.	(It is understood that a « repacking » station is a station for transhipment from/to wagons of the same gauge, whereas a transhipment station is a station for transhipment from/to wagons of different gauge, rep.)
om shed to shed; wide platforms at most sheds, because f received traffic is collected by consignees.	
average shed with approx. 150 tons incoming goods the is approx. 200 m and the width approx. 15 m; preference : arrow sheds, to restrict area to a minimum in view of nce distances but with sufficient line-up places for y vehicles (diagrams app. 5).	3 tracks are alongside one of the long sides of the sheddeck; for the use of removing the 1st and 2nd train of wagons (diagrams app. 5 *a* and *c*) between 2nd and 3rd track a platform with a width of 3 m which is solely used as a driving track.
idings to be of sufficient length to accommodate the r of wagons to be handled in half a day; platforms to e length of the sidings; width of platforms should be 50 ft for a single track shed, thus giving space for ing, operation of mobile cranes, fork lift trucks and for g	
of platforms in more modern depots : oing sheds : 3 - 5 m; ning sheds : about 5 m; hipment sheds : 5 - 10 m.	According to the Administration the ramps of the N.S.B. are, generally speaking, far too narrow.
e stations platforms are long and narrow, at others short de, depending on the traffic dealt with.	
e shed-sections not exceeding 100 m, overall length of not exceeding 300 m widths vary from 12 to 18 m; nce : for small depots length of shed not exceeding for large depots 200 - 300 m; platforms not narrower than not wider than 18 m.	
nce : short and broad design of depot, therefore more ne (short) platform; at the incoming shed one long longside the whole shed may be useful; if conveyors are longitudinal design of the shed may be useful; in depots internal conveyance is mechanized platforms should at e 3 - 3.5 m wide.	The introduction of conveyors has been investigated; any decision has not yet been taken.

QUEST

SEVERAL PLATFORMS

Administration.	*Linking of platforms.*
American Railroads	General procedure is to have platforms serving two t platforms of older goods stations are linked with lif movable bridges; some modern depots have electrically ope lift bridges which can be raised to platform height whe service and recede under the platform when not in servic
British Railways	Island type : by cartage units and removable bridges; grid (very long) : by removable connecting bridges.
East African Railways	Facing platforms; volume of traffic has, so far, not jus installation of lifts, movable bridges, etc.
Eireann Railways	Facing platforms; conveyance distance only drawback, bu alternative arrangement likely to be more efficient.
Indian Railways	Only in very large depots there are more than one pla for loading and unloading; they are normally not l together, except at large repacking sheds; however, a ro facing platform connecting the buffer-end side of the pla is provided; road or facing platform is more convenient movable bridges, etc., which have not been found necessa
Malayan Railway	Only applicable at Port Swettenham where lift bridges co platform of adjacent transit sheds.
Netherlands Railways	Facing platform at the buffer-end and hydraulic bridge i middle; very often by passage through wagons linke bridge plates facing platform and bridge rather seldom us conveyance distances are too long (diagrams opp. 5).
New Zealand Government Railways	Facing platform; no movable bridges, lifts, etc.
Norwegian State Railways	Facing platforms.
South African Railways	Platforms linked at one end.
Soviet Union Railways	Facing platforms; no mobile or lifting bridges.
Swedish State Railways	Facing platforms, when there are dead end sidings in the passing through the wagons or over a special bridge-v (see fig. 8/10) when there are through-tracks or when co ance distances via facing platform are too long.

ADJOINING TRACKS.

Non-adjoining tracks; passing through wagons on the adjacent track.	*Arrangements and special precautions.*
xistent.	
ed only in non-modernized layouts.	Accurate spotting of wagons, careful placing of bridging boards and provision of wheel stops to obviate inadvertent movement of wagons.
xistent.	
ed; loading boards used to bridge the gap between two ns.	No special precautions taken; Standard Regulations protecting wagons in the course of loading and unloading from interference by shunting movements are ample to cover this type of operation. Apart from this wagons are placed, as far as possible, in station order to facilitate marshalling on outgoing trains.
ally not allowed; when necessary loading boards are used vagons on adjacent track are used as passages.	Shunting is not allowed when loading or unloading; handbrakes of wagons are pinned down.
ormally allowed.	No special precautions taken.
al practice (diagrams app. 5).	No special precautions taken; standard regulations.
illowed; wagons are different types and doors would not hose of wagons on adjacent tracks.	
ed; fork trucks drive through two wagons on adjacent ; gangways between the wagons.	Special gangways protected against displacement are used.
ormally.	
ionally; then ramps are used as shown in app. 7.	

ng through the wagons is difficult, as the passage is narrow and does not afford a good view. If this be done frequently it may be preferable to use bridge-wagons. On the other hand, these bridge-ns have the drawback of binding valuable track space and complicating shunting. Movable bridges the same advantage, but do not affect shunting so much. A certain amount of accurate shunting however, be undertaken if the track space between the bridges is to be exploited. The *Swedish State ays* have a large number of wagon-types with deviating lengths; consequently the track space en such bridges can seldom be completely exploited.

QUESTI

SPACE I

Administration.	*Number and shape of bays.*
British Railways	Shape : a straight cartage front is preferred in all mod layouts; provision made for sufficient semi-trailers to be tail-on at the cartage front, 8'6" being allowed for each be
East African Railways	Not appl
Eireann Railways	No fixed design of depot; *obs. :* due mainly to economic considerations the Administra has not up to the present been in a position to moder and standardize goods sheds to any appreciable ext many of the sheds are legacies of the past.
Indian Railways	A few bays at only a few stations, as the sy
Netherlands Railways	Each bay is a rectangular section kept free on the shedc approx. 4 m wide (at the wall) and approx. 10 m long; betv bays approx. 1.5 m for loading the delivery vehicles.
New Zealand Government Railways	No standard size, number or shape of bays.
South African Railways	No special bays (road vehicles are required to tender goods rail transport on the side of platforms next to sheds f where the goods are conveyed either for storage in shed loading direct into wagon).
Soviet Union Railways	
Swedish State Railways	No rules are applied which

ERY SERVICES.

Storage available per ton handled.	*Free space for conveyance to delivery vehicles.*
cessary. he common practice of preloading vehicles precludes the sity for reserving space other than for traffic awaiting ictions and traffic brought back unable to deliver », ı comprises only a very small proportion of the total.	Dependent upon the type of layout, e.g. with conveyors : 3 to 4 ft wide with power trucks : 20 to 25 ft wide.
to question 6.)	
	10 ft wide is considered desirable.
ry to door is not in extensive use.	
y bay approx. 0.15 ton per m² (approx. 7 m² per ton l).	Approx. 1.5 m².
ndard storage space.	Normally about 9 ft.
	For manual conveyance : 4 - 5 ft; for mechanical conveyance : 10 - 15 ft; with turning points up to 20 ft, provided sufficient space is left vacant opposite all shed doors for manœuvring the particular handling equipment.
	Normally 2 m.
ı basis for an answer.	

QUEST

SITES FOR THE DELIV

Administration.	*Arrangement of the bays.*
British Railways	
East African Railways	Not applicable. *Obs.* : question misunderstood; see obs question 6; translation of question from French original fa Rep.)
Eireann Railways	(See answer to question 9.)
Indian Railways	Separate bays for traffic received from different direction from particularly large goods booking stations for facilit identification and easy removal after delivery.
Netherlands Railways	A small section of the sheddeck at one or more doors at road-side is reserved.
New Zealand Government Railways	No standard arrangement of bays.
South African Railways	Not possible to generalize:
Soviet Union Railways	(Question misunderstood : « delivery stations » = sub-g depots; Rep.)
Swedish State Railways	The size of the delivery bay varies from shed to shed, bu bay always constitutes the greater part of the incoming as most of the incoming goods are uplifted by the consi or their representatives. Only the smaller part of the shed is reserved for goods t delivered by the carriers employed by the Administration. delivery bay has a long platform on the street-side, which sh be at least 2 m wide to allow a certain storage of the goo connection with the uplifting by consignees.

)NSIGNEES AT STATION.

Storage available per ton received.	*Stacking facilities.*
·m or lock-up space is provided at or near the cartage for storage of « wait order » goods and for goods to be ·d by consignees.	The proportion of traffic to be held in storage of this nature is very small. Where no platforms are available, internal cartage units are used for temporary storage.
›plicable.	Not applicable.
ıswer to question 9.)	(See answer to question 9.)
are normally sufficient capacious to hold twice the daily e receipts, consignees being allowed to remove their without payment of wharfage by the midnight of the day ing arrival.	
goods to be uplifted by consignees are only a fraction he daily arrivals. A large own delivery service performs delivery to door; delivery charges are integrated in the vay freight; deductions for removal of the goods at the by consignees are not granted.	
›f the larger sheds are too small and this usually necessi-ome traffic remaining in wagons each night.	

ıeral the following storages-system is applied :
›ds for certain important clients are stored in a specially reserved section;
other goods to be uplifted by consignees the depot has been divided into sections marked with ers or figures; on unloading the goods are conveyed to the nearest section in which space is ilable; the designation of the section is then entered on the consignment note.

system has been based on two principles: *a*) good service to the clients and *b*) economic internal ance.

heless it entails certain inconveniences to consignees who call for consignments that have been placed ferent sections.

eriod of storage depends on whether the goods are to be uplifted by the consignee or to be delivered arrier employed by the Administration. The percentage of the total amount of goods delivered by s varies for the different stations from 0 to about 30. These goods remain at the depot for at 24 hours. For other goods the average storage period is about 3 days. The goods are placed on the floor. In some depots there are a small number of wall-shelves for small packages. In one depots also pallet-shelves have been installed for pallets with goods for one and the same consignee. ntended to try pallet-shelves in several depots.

QUEST

11. — Are your goods depots covered in or not?
Are there any special problems as regards the ventilation of your covered in depots, especially on account of :
— internal combustion engines vehicles;
— perishable goods.
How do you solve such problems?

COVERED AND UNCOVERED DE

Administration.	*Greater part of depot.*
American Railroads	
British Railways	Incoming and outgoing depot under one roof and with w (see drawings : app. 2).
East African Railways	Open.
Eireann Railways	Not Covered in.
Indian Railways	Not covered in.
Malayan Railway	
Netherlands Railways	New depots, closed, with doors also on the railtracks.
New Zealand Government Railways	Part of the yard has cantilever type open shelters.
Norwegian State Railways	
South African Railways	
Soviet Union Railways	Open.
Swedish State Railways	Open.

CHAPTER III.

HANDLING (METHODS AND EQUIPMENT).

A. Methods.

12. — *Please give, for your large goods depots, the operating methods used.*
— *Please detail the different operations of checking, weighing, handling, sorting and transport carried out.*

In their introduction before replying to the questions concerning the operating methods, the *Soviet Union Railways* say that the work in their goods depots is organized as a technical process in conformity with the time-table of the stations

TION PROBLEMS.

Shed and platforms.	*Ventilation problems.*
ith roof and walls.	No.
	No.
overed.	No internal combustion engines used inside sheds.
	No.
partially covered according to the quantum and nature c handled.	No.
sheds.	No.
ith roof and walls.	No; in sheds in which are also railway tracks : ventilators.
overed in.	No; as most sheds are open at both ends.
overed in; ramps partially not.	No.
majority of stations sheds are covered in, but sheds at er depots consist only of roofs supported by pillars.	No.
ith and without walls.	No.
overed in, platforms outside sheds with roofs.	No; sufficient precautions taken; carbon monoxide well below max. value stipulated by State Institute for Public Health (0.006 - 0.010 per cent).

for 24-hour periods and shifts. This timetable is drawn up by the station master on the basis of the programme for the region, the actual state of the work at the beginning of the planned period, train schedules and clients' instructions with regard to freight movement. The plan for loading, unloading and sorting of the goods runs parallel with the programme of work on the trains and marshalling, it includes times of service, duration of loading operations and time of removal of wagons from the loading and unloading points. Single shifts and complex gangs of workers, drawn from all shops, are formed in order to co-ordinate the work. They are provided with an overall diagram of the work. The single shifts consist of a.o. checkers from the goods yard, porters and gangs serving the mechanized handling

Fig. 9.
Swedish State Railways : Bridge-wagon (II - B - 2 *b*).

Fig. 10.
Swedish State Railways : Ramp for bridge-wagon (II - B - 2 *b*).

facilities. The general operational management of the work of a shift rests with the station dispatcher. In large depots the goods dispatcher is in charge of the work. In general he is responsible for :

- ensuring that the shift plan of loading and unloading is completely carried out;
- control of the correct servicing of wagons being loaded and unloaded;
- ensuring that the time limits fixed for the loading and unloading of wagons are adhered to, and that the latter are removed at the correct time at the conclusion of operations;
- informing the consignees of the progress of unloading;
- ensuring that sufficient men are available;
- supervising the work of the shift checkers.

Oganizing the work for the handling of the goods at departure at the Soviet Union Railways is easy as compared with the other Administrations, because it is known beforehand what and how many goods will be tendered for despatch.

In order to facilitate the work at the arrival station, the *Netherlands Railways* forward the waybills in advance. These travel to the arrival station by specially designated passenger trains.

At the *Eireann Railways* the waybill is passed to Invoice Office where the charges are raised and the invoice is prepared for forwarding to station of destination, generally by first suitable passenger train.

The waybills at the *American Railroads* are usually sent by mail and arrive in advance of the wagon.

1. At forwarding.

a) *from the arrival of a parcel at the despatching shed until it is loaded on a wagon.*

a) Place of tender.

All Administrations who have replied to this question dispose of sheds. Naturally the working methods of the various Administrations vary. The difference begins already when the goods are tendered at the shed.

At the *Netherlands Railways* the road vehicles, tendering the goods, need only unload at one point in the shed. At this point all goods, irrespective of their destinations, can be unloaded. Of this the *Eireann Railways* report that the system of « one point » acceptance of traffic has not been introduced in any of their sheds. A road vehicle arriving at the despatching shed with parcels for many different destinations may (and generally will) have to move on to more than one acceptance point to discharge all its load.

The *British Railways* and the *Norwegian State Railways* either unload the road vehicles directly into the wagon or unload the goods into the shed. From the answers cannot be concluded if the road vehicles have to move on to several accepting points whilst unloading into the shed.

The *Indian Railways* report, that normally the consignments for a certain direction and sometimes even for a certain station are accepted at a nominated shed or at one particular bay thereof. The goods transported by the *Soviet Union Railways* will probably also have to be tendered at different points in the sheds, as their sheds for the reception of parcels traffic are divided into sections and areas arranged according to the destinations of the goods.

b) Checking.

As regards the status of the checker the *Indian Railways* report that he is a goods clerk. The *Soviet Union Railways* state that the checkers are responsible for seeing that all commercial operations are completed without delay; their number and presence at loading points depend on the character and scope of the work.

The checker directs the work of the gangs of porters and drivers of mechanized

vehicles engaged in loading, unloading and sorting operations.

At the *Netherlands Railways* the responsibility of the checker is limited to his own work. As is the case at the *Eireann Railways,* the checker is also charged with work in connection with the weighing of the goods to be despached.

At the *Netherlands Railways* the goods tendered are distinguished in goods from customers who themselves apply to the goods journey labels, on which the group head station of destination is indicated (labellers) and in goods to which a journey label has still to be applied in the depot. The goods of « labellers » are tendered single or in boxes or pallets. Of the single ready labelled goods the packages are counted and the total number is checked with the total number according to the waybills.

Tests at random are made to ascertain if labelling is done properly by consigner and if the addresses on the packages correspond with those on the waybills.

As the goods tendered in boxes or on pallets are already combined per group (head) station as much as possible, checking in the depots takes place by comparing the number of packages per group with the accompanying waybills. The checking of goods from « non-labellers » is somewhat more extensive. Of these goods the data on the packages are checked with the data on the waybills; these goods are moreover examined whether the consignments comply with the regulations for parcels traffic.

At the *Swedish State Railways* directly at acceptance the goods are controlled to ascertain if they may be accepted for transport by rail; after weighing the goods are checked with the waybills. It is pointed out that the checking of goods with waybills is omitted if an agreement has been made between the railway and the consigner to the effect that this need not take place and that the railway will not be held responsible for any consequent errors.

From the reply of the *Soviet Union Railways* it appears that all goods are subject to the same control at which checker has to verify the agreement in the nomenclature of the goods and number of parcels with the data shown on the waybill, the condition of the packing and its conformity with the standard laid down for that particular type of goods and the presence and correctitude of consigners' labels.

Also at the *South African Railways, Malayan Railway, New Zealand Government Railways, British Railways, Norwegian State Railways* and the *Indian Railways* no distinction is made, and all goods and waybills are checked. From the answer of the *Indian Railways* it appears that checker also has to control the route in case consigner selects a dearer route.

At the *Eireann Railways* special attention is paid to valuable articles. Together with articles liable to pilferage (such as tobacco, wines and spirits, drapery etc.) these goods are recorded on acceptance by the checker in a special register and a record is made in course of the number of the wagon in which the goods are loaded for despatch.

Registration by the checker is also known at the *Soviet Union Railways,* where after having been weighed all goods are entered in the acceptance registers by the checker.

c) **Weighing.**

The answers of the *American Railroads* and the *Malayan Railway* do not disclose if the goods are weighed before despatch and if there is weighing equipment in the depots.

The *Netherlands Railways* employ scales, fitted with a dial from which the weights can be read. These scales are either let into the sheddeck and therefore only to be used at fixed places or mobile enabling their use at any place.

The *South African Railways* also have equipment for weighing very heavy consignments. If a package is tendered of

such dimensions that it requires loading by cranes, the truck is passed over a weighbridge.

The *British Railways* also employ a weighbridge because after arrival of the cartage unit at the depot cartage vehicle with load is weighed.

The *East African Railways* have installed dormant scales at each acceptance point.

Of the remaining Administrations it is not known what type of scales are used in their depots.

From the above survey it is clear that most Administrations have equipment to weigh the goods. From the answers can be concluded, however, that not everywhere all goods to be despatched are submitted to some sort of weighing.

At the *East African Railways*, the *Eireann Railways* and the *Indian Railways* all tendered goods are weighed. The *Netherlands Railways, South African Railways* and *New Zealand Government Railways* only weigh the consignments which have not yet been weighed by consigner. At the *Swedish Railways* weighing may be omitted if the weight of the goods has been stated by consigner. At this the same observation is made as at checking, viz. that weighing is omitted if an agreement has been made between the railway and the consigner to the effect that this need not take place and that the railway will not be held responsible for any consequent errors.

At the *Soviet Union Railways* the goods in tare, the weight of which is determined at packing and indicated on each article, as well as packages of a standard weight are not weighed at acceptance. The total weight of such consignments is established and indicated on the waybill by the consigner. The total weight is calculated from the standard weights as shown on the packages.

The *British Railways* have a regulation that consigners should declare the weight of consignments. True this direction is not always observed, but the majority of consigners adhere to it. For the weighing of consignments not yet weighed by consigner or for carrying out test weighing, facilities are provided.

The *Norwegian State Railways* weigh all the goods having no standard weight or of which the weight is not indicated on the waybill.

In cases of large consignments from client to station the goods are assembled on pallets, platforms, etc. by the consigners before being weighed.

In the case of direct delivery of the goods from consigner's vehicle to the wagon the weight is generally estimated for goods not being weighed in advance or having no standard weight.

d) Other handling at acceptance.

At the *Netherlands Railways* apart from checking and weighing, packages which no freight calculation according to a fixed amount per 100 kg underlies, have to be measured with the aid of a rule to determine the volume of the goods. If these goods weigh less than 300 kg per cubic metre a freight calculation is applied deviating from the normal calculation.

The « scale hand » (also checker and weigher) writes his initials and if necessary the dimensions on the waybill. Then a journey-label is applied to every package, indicating in clear characters the « group head station » of destination.

The *Soviet Union Railways* and the *Indian Railways* also mention applying railway marks to a consignment. At the *South African Railways* the checker has to sign the carbon copy of the waybill and hand it to the consigner as his receipt. The checker of the *Eireann Railways* passes his signature for traffic after checking. At the *American Railroads* the shipping order is marked to indicate the outgoing wagon into which the consignment is to be loaded by a railway employee.

e) Handling after acceptance.

At the *Swedish State Railways* after checking, weighing and other handlings to be performed at acceptance, the goods are loaded on pallet, trailer or wheelbarrow, conveyed on these facilities and loaded in the wagon.

The goods to be handled by the *Soviet Union Railways* are stowed into sorting bays according to the directions of the checker. In mechanized sheds served by powered trucks the goods after having been unloaded from the road vehicles are stacked on pallets and arranged in the corresponding sorting bays. The *South African Railways* report that the handling of the package depends on its size and weight and on the equipment available at the particular station which may be anything from a hand trolley to a mobile crane. At the *East African Railways* traffic is conveyed, usually by wheelbarrows either to the wagon into which it is to be loaded or to loading bays.

The *Malayan Railway* do not seem to exert any influence on the working method because all goods sheds employ contract labour for the handling of traffic.

The *New Zealand Government Railways* convey the goods by means of a wheelbarrow and load them into the wagon. Particulars of wagon number, time of receipt, date and checkers initials are entered.

The working method at the *Eireann Railways* is dependent upon the position of the wagons. If an empty wagon for loading to destination station is already placed at the shed-platform the goods to be unloaded from the road vehicle are generally loaded immediately into the wagon, in order to save handling. In other cases they are placed on the shed-platform in space reserved for traffic for the same destination in order to be loaded in due course when the wagon is placed.

The *British Railways* distinguish two systems viz. « direct loading » and the « platform method ». With « direct loading » the load of a cartage unit is broken down if necessary after arrival at the depot, whereupon perambulation to and stowing into outgoing wagon takes place. With the « platform method » the cartage vehicle is set up at a platform. Traffic is sorted and moved in bulk or on wheelbarrows to outgoing wagons after which the goods are stowed into the wagon. The goods of the *Norwegian State Railways* are conveyed directly from the weighing devices to the storage space or, if possible, directly to the wagon. In cases of large consignments the goods are assembled by the consigners on pallets, platforms, etc. In the other case the goods are more or less assembled into bigger units after having been weighed, if the conveyance distance is considerable or if the goods are to be stored in the shed.

The *Indian Railways* employ wheelbarrows and for heavy packages also cranes are used. The consignment is transferred to the wagon earmarked for its journey from the forwarding station by porters under the supervision of a loading clerk who while supervising loading in the wagon takes down a tally of the packages, and when the wagon is fully loaded, prepares a summary of its contents and places a copy thereof in the wagon before same is sealed and despatched.

At the *Netherlands Railways* again a distinction should be made between goods originating from « palletpool consigners », « labellers » and « non-labellers ». The goods of « palletpool consigners » consequently loaded per destination and tendered in boxpallets or on pallets, are unloaded from the roadvehicle by means of a handfork truck and conveyed to an assembly point at the driving track where the pallet units are placed according to forktruck rider (fig. 22 and 23 Ch. V). Every forktruck rider is responsible for a number of wagons assigned to him. From these assembly points the units are conveyed to the wagons and stowed therein

by means of a powered forklift truck. The boxpallets and pallets loaded with goods for several destinations go to the sorting area. The full boxpallets in the sorting area are conveyed to the wagons and stowed with the aid of a powered forklift truck. So the goods are loaded in the wagons loaded on the boxpallets or pallets. In order to acquire proper stowage there are directions in this respect and every forktruckrider is responsible for the wagons assigned to him.

The goods of « labellers » which do not arrive in boxpallets or on pallets, are directly put in boxpallets or on pallets, while unloading the roadvehicle.

Further handling is identical with the handling of goods from palletpool consigners. The goods originating from « non-labellers » are palletized after having been handled at the scales and from then on are handled in the same way as the other goods. Unpalletizable goods such as bicycles, perambulators, mattresses, etc. are either carried to the wagons or conveyed there with the aid of a wheelbarrow.

f) Sorting.

The sorting of the goods is not described at length by most Administrations. The *Netherlands Railways* observe about the sorting areas in their depots that they have approx. 500 boxpallets, standing there, corresponding with the group (head) stations. These boxpallets stand in two double rows. To keep the sorting area as small as possible the boxes are stacked, so that two boxes stand on top of each other. To increase the accessibility of the lower box the one on top is put backwards a little.

The sorting of the goods by the *Soviet Union Railways* is done on sorting platforms which are to be found at regional and sorting stations. The goods are first spread out on sections of the platform arranged according to the various destinations and are then loaded into wagons drawn up against the corresponding sections. The sorting of the goods is done by checkers and sorters who have great practical experience and a sound knowledge of the railway network. Each checker is in charge of a gang of porters. The senior checker is in charge of the other checkers and sorters.

2. At receipt.

b) *From the arrival of a parcel in the wagon until it is handed over to the arrival shed.*

a) Checking.

At a great many Administrations the goods are checked directly while the wagon is being unloaded. Other Administrations do not check the goods at unloading, but when the delivery vehicles are loaded or when the goods are collected at the shed by the consignees.

The *Swedish State Railways* check the addresses and the dates of the goods with the waybills when unloading the wagon. The check is made by means of a telephone connection between the wagon and a special checking-room where the waybills are kept.

At the *Soviet Union Railways* the goods are unloaded from the wagon into the shed under the supervision of the checker. As at despatch the checker plays an important part in the handling of the arrival goods. He compiles a plan for the disposal of the wagons and for the most rational storage of the goods in the shed; he takes into account the station plan of work, information from the goods despatcher as to the time of delivery of wagons for unloading and the character and quantity of the goods, obtained from the wagon lists. He then informs the porters and the powered truck operators of his decisions. On the arrival of the wagons at the shed the checker supervises their disposal along the unloading front. Before unloading starts the checker examines the wagons; while unloading takes place he verifies the number of

parcels and their conditions and, if necessary, he weighs separate items.

The *Eireann Railways* have appointed two persons for checking, a checker and a « caller-off ». The « caller-off » reads out particulars of traffic from the labels to the checker who records same in an incoming check book. The entries in this book are reconciled later with the invoices and a special record is made of discrepancies which are followed up. For returned empties traffic there is no check at the wagon side. The road sheets prepared for delivery purposes are the only incoming checks available.

At the *American Railroads* the goods are apparently checked also when being unloaded from the wagon. This can be concluded from the observation that the waybills are processed immediately to facilitate checking the consignments and unloading the wagon when received.

At the *New Zealand Government Railways* and the *Norwegian State Railways* the goods are checked with the waybills at the unloading of the wagon. At the latter Administration checking has been cancelled at certain stations for some routes. When a check is made, the section where the goods are to be unloaded is, if necessary, marked on the waybill.

At the destination stations of the *Indian Railways* the seals of the wagons are checked to see if these are still intact and the wagon is then opened. The contents are checked with the entries in the summary of the wagon, which is produced from the wagon itself. Should any package be found deficient or damaged in some way or other, the condition is noted on it and it is weighed in the presence of the Railway Protection Force Staff, the condition being advised to the last sealing station. The reply of the *British Railways* does not indicate where the checking point is. The checker does, however, stow parcels on the cartage unit and makes out the delivery sheet from information on the package label. Checking will probably be carried out while loading the delivery vehicles. This same checking point we find at the *Netherlands Railways*. But a special checker is not appointed for this. The goods are loaded by the delivery men into their vehicles, according to the consignment notes supplied to them. Possible irregularities discovered by the delivery men are communicated to a special branch of the depot who take care of further steps.

b) **Handling.**

The description of the handlings performed to convey the goods from the wagon to the delivery point in the shed show that at several Administrations some consignments are directly conveyed to the delivery vehicles, whereas the remaining goods after having been sorted are placed in the shed sections for their respective destinations.

The *Eireann Railways* write that a discharge gang normally consists of four men per wagon (one checker, one caller-off and two porters). The goods are conveyed as directed by the checker, by the porters either on hand trucks or on manual operated trolleys to be loaded direct to the road unit for delivery or if no unit is placed at the time, the goods are stacked on the shed platform in specially designated areas adjacent to the ultimate delivery point. In this connection the use of stillages in conjunction with collis handtrucks is being very successfully developed. The wagons with returned empties traffic are placed at a special « empties » platform, which is generally roofed but is open on all sides. Ultimate delivery is carried out by articulated trailer units.

At the *American Railroads* consignments for local delivery are in some cases directed direct to the road vehicle or are temporarily stored on the platform for later loading in sequence of delivery.

The *British Railways* apply several working methods :

a. from wagon to single conveyer direct to cartage units. The parcels are trans-

ferred from wagon to conveyer. If necessary the packages are marked with delivery area or appropriate outgoing wagon road and are thereupon transferred from conveyer to delivery unit or internal station unit;

b. from wagons to two or more conveyers with primary sorting to internal vehicles and final sorting to cartage units or outwards wagons. After the unloading of the packages on conveyers and, if necessary, marking with delivery area or appropriate outgoing wagon road sorting takes place from conveyers to internal station-units; bulk conveyance to cartage front or outgoing wagons;

c. from wagons by powered platform trucks (with or without stillages). In this case suitable loads are built up for bulk conveyance to appropriate sections of cartage front or outgoing shed, where parcels are distributed to appropriate vehicle berths.

At non-modernized sheds conveyances take place with wheelbarrows with the only difference that parcels are moved in smaller quantities. At the *Netherlands Railways* large consignments and consignments which together form a vehicle load for one consignee are unloaded by means of forklift trucks and are conveyed direct to the roadside of the shed. Here the goods are unloaded from the boxpallets or pallets and stowed into the delivery vehicles. For the handling of small consignments the shed is divided into a few sections; each section contains a number of adjacent districts or delivery rounds. The goods are unloaded from the wagons by means of forklift trucks and conveyed to a pre-sorting area. Here the goods for the districts or delivery rounds of one section are assembled on platform trucks or stowed in boxpallets per « secondary station » in the « group ». The platform trucks convey the goods to the appropriate section where the goods are spread over the districts or delivery zones. The boxes are loaded into the wagons for the « secondary stations » with the aid of forklift trucks.

The *Swedish State Railways* load the goods on pallet trailers or wheelbarrows. After conveyance with the aid of these facilities the goods are placed in the shed.

At the *Soviet Union Railways* when the wagons arrive at the station of destination the railway lists and waybills are sent from the technical office to the goods office and the wagon lists to the goods yard. The goods office informs consignee of the arrival of the goods on the day these arrive at the station. The goods are unloaded from the wagons and placed on pallets for conveyance. At one of the loading points the checker indicates with chalk the serial number of the platform to which the goods are to be conveyed. Guided by these markings the operators of powered trucks carry out the necessary conveyance. The unloaded consignments are stored separately.

The checker informs the goods despatcher when unloading is completed, he notes on the wagon list the location of each consignment after which he sends the wagon list to the goods office.

The *South African Railways* do not describe their working method but rather emphasize the transportation from one station to the other.

At the destination stations of the *East African Railways* the goods are conveyed from the wagons by wheelbarrows and at certain large depots by rider operated electric tractors and trailers direct to delivery or stacking bays where they await clearance by consignees.

At the *New Zealand Government Railways* the incoming goods are put on wheelbarrows and conveyed to the storage area. The bay number is entered on both copies of the waybill. The number of the waybill is written on the parcel for identification purposes on delivery. Checker's initials, time and date are also entered on the waybill. The *Norwegian State Railways* sometimes combine the goods into

bigger units especially large consignments to one consignee and goods which are to be transported to remote destinations. The goods to be called for by the consignees are assembled in sections (one section at each door) according to the nature of the goods and the name of the consignee. Goods to be delivered to the consignee are assembled in accordance with the delivery zones.

At the *Indian Railways* after unloading the packages are sorted out stationwise. For stations from where traffic is heavy separate space is allotted in the incoming shed where parcels are stored pending delivery to consignees. The consignments received from other stations are stored together, but the locations are indicated in the unloading book by the pillar or bay number. The packages unloaded are made over to the shed delivery clerks who are responsible for their further disposal.

3. At transhipment.

c) *For the transfer from one wagon to another in the case of transhipment from railway to railway.*

For most Administrations transhipment of the goods will arise from the organization of parcels traffic.

The *Netherlands Railways* for instance have a « group wagon service » in which regular connections have been set up between the « group head stations ». In the traffic to and from these group head stations the goods consequently need not be transhipped. The goods, however, originating from or destined for less important towns (secondary stations) with rail connections are transported to or from the group head stations in « dump wagons ». These goods have to be transhipped at the « group head stations ». Apart from the organization the *Indian Railways* also have to take into account the differences in gauge of the railway tracks; they discern repacking from one wagon to another of the same gauge and transhipment from one gauge to another.

Several Administrations administrate or check the goods transhipped from railway to railway. Where this check is made it probably takes place in order to ascertain the responsibility between different lines (Soviet Union Railways) or different Railways.

a) Checking and clerical work.

At the *Indian Railways* the general work for repacking for the day is planned in advance in the morning. The Head Transhipment Clerk arranges to open the incoming wagons, takes out the summaries, analyses the loads and lays out the general plan of repacking and further despatch of all incoming consigments to be dealt with. Each Transhipment Clerk is allotted a particular number of incoming wagons. The contents of the wagons are checked with the summaries obtained from inside the wagons and according to the general plan outgoing wagons are prepared. The Transhipment Clerk prepares a summary of the contents of each outgoing wagon and places a copy thereof inside the wagon, another copy being sent to the destination station or the repacking point or break of gauge junction as necessary. Details of transfer of all packages from one wagon to another are entered in the Transhipment Register maintained for the purpose.

The *Soviet Union Railways* do not mention checking but say that at points where loads are transferred from one line to another only a registration of consignments and of stowing equipment (bread shields, tarpaulins, etc.) handed over, is carried out. In their elucidation they say that this registration is not only essential for the delimitation of responsibilities between lines and for material valuables in transit, but also for studying the flow of goods, the control of the progress of the goods and transfer of stowing equipment and finally to enable an enquiry to be made in the event of late arrival of goods.

The registration of a transfer of goods

from railway to railway is carried out according to official lists compiled by clerks of the station accounts bureau from the documents in the technical offices.

The goods transhipped at the *New Zealand Government Railways* are checked, after which checkers initials, date, time and new wagon number are entered on the waybill.

The *Eireann Railways* apply the same method at unloading as when unloading incoming goods which need not be transhipped, so this is done by one checker, one caller-off and two porters.

The *American Railroads* also refer to the handling of the goods not to be transhipped, the incoming waybills are marked to indicate the disposition of the consignment, be it either a wagon or a truck.

At the *British Railways normal* transhipments are not checked because there are no waybills or invoices. Where transhipments involve crosstown cartage, packages are listed when stowed on cartage vehicles and checked with the list on arrival at the other depot.

The other Administrations do not check the goods and do no clerical work at transhipment or do not enter into this subject.

b) Handling of the goods.

Most Administrations do not or only summarily go into the working-method, according to which transhipment is executed. The cause of this may be that the working method(s) applied are very simple or that transhipment of goods is less important.

At the *East African Railways* and the *Eireann Railways* the working-method depends upon wagons being available. The East African Railways say transhipment goods are either transferred direct from wagon to wagon or from wagon to loading bays. At the Eireann Railways the goods to be transhipped are loaded direct into the outgoing wagon if same is placed, otherwise the goods are stacked on the shed platform in a specially allocated area as close as possible to the ultimate loading point where the outgoing wagon is placed in course.

The *South African Railways* write that the working-method depends on the facilities available, the provision of which is based on the requirements of the particular depot.

At the *New Zealand Government Railways* the goods are placed on wheelbarrows whereas the *British Railways'* packages perambulate on internal station units. The *Norwegian State Railways* only state about the transhipment stations that goods and waybills are not checked and that in the case of long transports it is tried to assemble the goods in bigger units.

The *Swedish State Railways* when unloading the wagon place the goods on pallets, trailers or barrows, after which they are conveyed and stowed into the wagons.

At the *Soviet Union Railways* two methods for transhipment of goods can be discerned. The first method makes use of the fact that in any given wagon there is a preponderance of goods for a certain destination. Parcels for this destination remain in the wagon and other packages for the same destination are added during sorting. The other method makes use of the empty wagons arriving simultaneously with the loaded ones for carrying goods from wagons which have already been sorted without having to lay them out on the platform. As already observed above the *Netherlands Railways* execute transhipment on arrival and departure of the goods at « group head stations ». For transhipment on arrival two methods can be discerned, viz. transhipment of goods loaded in separate boxpallets or on pallets and transhipment of goods loaded among goods for the « group head station » itself. If the goods are loaded in separate boxpallets/pallets, then further sorting is not necessary. The forklift truck gets the

boxpallets or pallets out of the group-wagon and conveys and stows them into the « dumpwagon ». If the boxpallets or pallets are loaded with goods for the « group head station » and the « secondary station » then these units are conveyed to the sorting area after unloading (see working-method « at receipt »). When the boxpallets and pallets for the secondary stations in the sorting area are full they are conveyed and stowed into the dump-wagon by the forklift truck. The working-method for the transhipment of outgoing goods is almost the same as for incoming goods. If there are goods for one destination in the boxpallet or on the pallet the boxpallet or pallet is conveyed by forklift truck direct from « dumpwagon » to « groupwagon ». If a boxpallet or pallet contains goods for more destinations then this boxpallet or pallet is got out of the dumpwagon by forktruck and conveyed to the sorting area. In the sorting area (see working-method departure-sorting) the goods are loaded into the boxpallets or pallets for the various « group head stations » conveyed by the forktruck and stowed into the wagon.

4. Stacking of pallets in the wagon.

16. — a) *Do you stack the pallets or pallet-crates inside the wagon?*
What are the advantages, drawbacks or difficulties encountered?

The replies to this question once more illustrate that at most Administrations palletization is only at the beginning of its development.

The *Netherlands Railways* only have proceeded so far in this development that the goods for all destinations are loaded in boxpallets or on pallets and are stowed into the wagons, pallet and all.

The *American Railroads* only despatch goods in boxpallets or on pallets to receiving stations equiped with powered platform trucks. At the *Swedish Railways* pallets are loaded in the wagon only on a very small scale.

The *Soviet Union Railways* report they are not beyond the experimental stage as regards loading pallets in the wagons. The remainder of the Administrations do not know this matter by experience.

As regards the advantages of stacking pallets and boxpallets in the wagons the *Netherlands Railways* say that with the employment of these facilities a better use of the wagons can be made of. When the boxpallets and pallets are properly loaded and the wagons are well stowed, almost the entire space available can be used. The time needed for loading a wagon can be reduced considerably. The packages need not be put on a pallet or a means of conveyance one by one but are unloaded several at a time (approx. 18) on pallets or in boxpallets from the wagon. As the boxpallets and pallets are placed on top of each other in the wagon as well, care should be taken that boxpallets are not loaded higher than the edge and that pallets are loaded as firmly as possible and well stackable. Boxpallets and pallets sometimes have to be picked up and put down again for a second time in order to acquire better stowage of the wagon, which is a drawback. Stowage of the wagon is carried out according to fixed rules, which make it possible to obtain proper loading with a high degree of safety for the goods. The main principle is that imaginarily the wagon is divided in two in length and width, thus creating four equal (imaginary) sections. One of these sections is used for the unpalletizable goods, (bicycles, perambulators, etc.). Aside of these goods in the adjacent quarter of the wagon, boxpallets are placed which can be used for steadying the single goods. The other half of the wagon is loaded with stacked pallets, which again is done according to fixed rules (heavy below — light at the top, liquids and paint always below, etc.) (fig. 11). When the wagon is almost full, then boxpallets

are placed in the remaining space in the middle of the wagon near the door, with which the load is steadied. Goods loaded in wagons stowed according to this method are properly safeguarded against marshalling jolts and other rough handling during transportation of the wagon.

As regards this question the *Swedish State Railways* report that they have met with following difficulties with the palletization of goods :

— the parcel will slip off the pallet if it is not sufficiently firmly fixed;

— the lower parcels may not stand stacking or may be of a nature which makes them unfit to be stacked. The road carriers endeavouring to acquire transports of goods easy to load (crates, cartons and the like), the railway must often accept goods that are not easy to load.

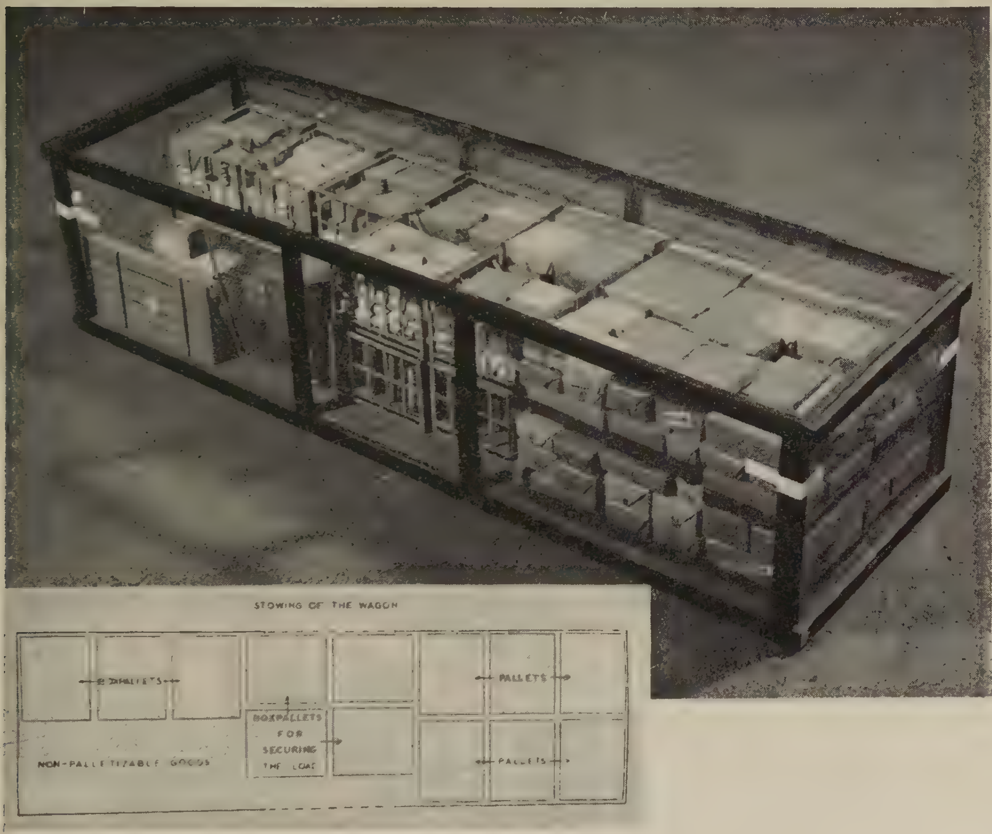


Fig. 11.

Van Gend & Loos. Instruction model of a full-packed standard parcels-wagon (III - A - 4).

B. **Equipment.**

1. **General.**

13. — *What machines or equipment are used?*

a) *for ordinary handling (handtrucks, trolleys, platforms, tractors, roller-conveyors, etc.);*

b) *for special handling operations, for example very heavy parcels or those of special forms (pulley-blocks, mobile cranes).*

Please give :

— *their main technical characteristics;*

— *any special purpose for which they are used;*

— *their normal radius of action, and if possible the hourly output obtained in tons handled per man.*

14. — *What means do you use to facilitate and speed up the operations of sorting or transporting the parcels within the sheds :*

— *trains of trolleys pulled by a tractor;*

— *various mechanical conveyors (rectilineal or in a closed circuit);*

— *conveyor belts built into the platform;*

— *turntables in the sorting depots, etc.*

Please give the essential characteristics of the equipment used by your Administration, and state in particular :

a. *in the case of equipment used for sorting, the number of destinations which this makes it possible to cover;*

b. *the average hourly output in tons (give the average weight of the packages dealt with);*

c. *the number of men used for driving and servicing;*

d. *the hourly cost of the equipment used (as regards the power supplied, maintenance and sinking fund charges) in relation to the hourly wage of the men.*

Most Administrations answer question 14 very superficially. In many cases this question was misunderstood to be an extension or a partly repetition of question 13. Therefore both questions were put together at the head of this chapter.

a) For ordinary handling.

Answering this question most Administrations restrict themselves to mentioning the machines or equipment. Further particulars concerning the main technical characteristics, special purposes for which they are used or their normal action radius in many cases were omitted.

The annexed list offers a review of the particulars communicated by the Administrations. In these it is striking how many types of equipment are used by the *American Railroads* and the *British Railways* for ordinary handling. It naturally is not probable that all these facilities are used in one depot.

At the *Eireann Railways* no mechanically propelled facilities are used.

The *Indian Railways* use mechanically propelled platform trucks at a few large sheds only.

The *Malayan Railway* has no mechanical handling equipment except in Port S'ham, where besides forklift trucks also three mechanical conveyor belts are available which are used for the handling of rubber.

The *East African Railways* only have a limited number of electric platform trucks at the larger stations. The cause of this is stated to be that the heterogeneous types of goods carried over the services do not lend themselves to fully mechanized handling methods; besides it is said that the high capital and overhead cost of me-

chanical equipment is such, that in general it cannot at present compete economically with the relatively low cost of labour. This last argument probably is the main reason for the great differences in equipment used in the depots.

It is striking that in a country as Sweden, foremost in the field of mechanization, the *Swedish State Railways* are occupied with a further development of the wheelbarrow. The Swedish State Railways have steel barrows and wooden barrows. The steel barrows are considerably heavier than the wooden types and consequently are not so popular with the staff.

In Sweden trials are now made with a type of barrow of lumber core with wheels of plastic. These trials have so far been satisfactory.

At the *Swedish State Railways*, the *Netherlands Railways* and the *Soviet Union Railways* forklift trucks are employed for conveyance. This rather modern equipment can to some extent hamper the application of other modern means of conveyance.

The *Swedish State Railways* namely say, that in view of the organization being based on the use of forklift trucks and pallets it is not considered advisable to install conveyors. In the design in which they have previously been constructed these facilities have complicated the use of pallets and containers. The possibility of using conveyors has not yet been dismissed altogether, as for some years there have been discussions concerning the installation of conveyors which convey the pallets by means of handfork trucks coupled to the chain-conveyor. With this system it is said to be possible to retain the pallet organization, and an unbroken chain of unit loads would be practicable. Especially when the conveyance distance is considerable this can be advantageous. The *Swedish State Railways* have calculated that with distances of approx. 150 m the forklift truck becomes unprofitable. To bridge these distances the Swedes prefer the combination of forklift trucks and trailers. The advantages of these are that long distance conveyance is thus made more economic and that the forklift truck is given a more all-round use.

b) **For special handling.**

Special facilities for handling heavy packages are part of the equipment of practically all Administrations.

At the *Netherlands Railways* these facilities are not in use because the maximum weight of a parcel is 500 kg. Special equipment for heavy parcels is very seldom used at the *Swedish State Railways*. In cases in which the loading equipment does not permit loading or unloading of the goods at the depot, these operations take place direct between the vehicle of the railway user and the railway wagon on a free loading siding or platform track. It is added that it is incumbent upon the Railway to accept goods for which special equipment is needed for loading or unloading only if such equipment is available at the outgoing station, as well as the incoming station. In practice, however, there are probably no instances in which the Railway refuses to transport goods for this reason.

The *Indian Railways* as a rule handle heavy consignments with hand-operated and mobile cranes. Fixed cranes are only available at stations where consignments requiring the use of cranes are handed daily as a regular feature.

If at a station extra big or heavy consignments have to be handled and the station has no equipment for such handling, then bigger mobile cranes are called in. These cranes are stabled at various important points on the railway. These mobile cranes are mounted on rail trucks.

A survey of the equipment for the handling of big or heavy consignments owned by the various Administrations is to be found in annexed list.

c) **Sorting.**

It clearly appears from the answers that no equipment is employed for sorting,

	Wheelbarrow	*Non-powered platform*	*Non-powered non-elevating trailer*	*Wheeled stillage*	*Powered truck with fixed platform*	*Tracto*
American Rail-roads. . . .	in use no further particulars	in use no further particulars	in use no further particulars	in use no further particulars	in use no further particulars	in us no furth particula
British Railways	in use no further particulars	in use no further particulars	average load 27 cwts. max. load : 50 cwts. platform : 15' × 7' height : 3' 8" above road level	height 1'2"	in use no further particulars	in use no furth particula
East African Railways . .	—	—	—	—	electric no further particulars	
Eireann Rail-ways . . .	no further particulars	with stillages no further particulars	—	—	—	—
Indian Railways	carrying capacity approx. 190 kg	carrying capacity approx 560 kg hauled by 2 men	—	—	in use no further particulars	—

Equipment for special handling.

...l truck ...evating ...orm	*Roller runway/ belt conveyor*	*Miscellaneous*	*Stationary crane*	*Mobile crane*	*Gantry crane*
...ise ...rther ...ulars	removable roller no further particulars	under floor and overhead chains		mobile heavy-duty crane	
...ise ...rther ...ulars	- slat conveyor height above deck level ½" width 3 feet speed 20-40 feet/min. - rubber belt conveyor width 3 feet speed 80-120 feet/min. free rollers attached which are 15" above platform level	- elevating, non-powered plat-form truck - semi trailer - small wheeled container ap-approx. 2 cubic meters		jib can enter covered vehicles with a reach of up to 6'	
–	—	—	—	straight mechanical; petrol or diesel powered; capacity 4 or 6 tons; max. reach: ranging from 10' to 26'	—
–	—	—	—	capacities 6, 7½ and 2 tons; 7½ tons : diesel powered, pneumatic tyres 6 and 2 tons : powered with petrol engines driving a generator which supplies the electric power for motors controlling the various motions; pneu-matic tyres; reach of 6 ton-ner : 4' 6"; max. lift above ground level: 20'	—
–	—	—	5-tons hand crane, radius of action 14' 10-tons hand crane, radius of action 20' 10-tons steam crane, radius of action 20' 30-tons steam crane, radius of action 20' 35-tons steam crane, radius of action 20' 65-tons steam crane, radius of act. 18-20'		

	Wheelbarrow	*Non-powered platform*	*Non-powered non-elevating trailer*	*Wheeled stillage*	*Powered truck with fixed platform*	*Tracto*
Malayan Railways . . .	—	—	—	—	—	—
Netherlands Railways . .	capacity 1 000 kg dead weight 40 kg solid rubber tyres fitted with ball bearings	capacity 2 000 kg platform : length 2 250 mm width 1 200 mm height 500 mm solid Continental tyres 415 × 75 TKP	—	capacity 1 000 kg platform : length 1 400 mm width 850 mm	—	Still, ty EK-ZF hauling cap 10 000 overall len 2 400 m overall wid 1 000 m overall hei 1 290 m radiusofgyr 3 120 m battery : vo 80 volt capacity 98 amp/h
New Zealand Gov. Railways	in use no further particulars	in use no further particulars	—	—	in use no further particulars	—
Norwegian State Railways . .	in use no further particulars	in use no further particulars	in use no further particulars	—	—	in use no furth particula
South African Railways . .	here called handtrolleys no further particulars	—	—	—	—	small trac no furth particula
Soviet Union Railways . .	twin axled (?)	in use no further particulars	in use no further particulars	—	freight capacity : 2 000 kg speed : loaded : 4-5 km/hour unloaded : 10 km/h road clearance : 64 mm	electric tr is used as tr and as p mover

...red truck elevating ...tform	*Roller runway/ belt conveyor*	*Miscellaneous*	*Stationary crane*	*Mobile crane*	*Gantry crane*
—	mechanical conveyor belt				
...trocars : ...g capacity ...00 kg ...g capacity ...00 kg ...form : ...2 000 mm ...1 000 mm ... 590 mm ...l length ...80 mm ...ll height ...0 mm ... of gyra- ...500 mm ...bber tyres ... : voltage ... volt ...pacity ...mp/hour	a few belt con- veyors for trials	—	—	—	—
—	roller runway no further particulars	—	in use no further particulars	capacity 2½ to 5 tons	capacity 10 cwt. to 2 tons
—	—	—	—	capacity 3 and 6 tons	—
...onveyor ...further ...iculars	—	—	—	different sizes no further particulars	—
... capacity ...00 kg ...: loaded ...m/hour ...aded : ...km/h. ...earance : ... mm ...lius of ...tion of	—	- non powered elevating plat- form truck - powered rider controlled plat- form truck		- *jib cranes with a traverse of* 180° : lifting capacity with jib extended 2-7 tons volume of grab 1,5-3 m^3; forward motion 75-165 meter/min.; time rise from lowest to highest position 1,5-2,5 min;	capacity 5 000 kg; without consoles and with two consoles clearance measurements : width 13,0-21,9 m length 7,0 - 8,6 m height 9,2 - 10,8 m speed : forward movement 20-60 m/min.

	Wheelbarrow	*Non-powered platform*	*Non-powered non-elevating trailer*	*Wheeled stillage*	*Powered truck with fixed platform*	*Tractor*
Soviet Union Raylways . . (continued)					radius of gyration of outer edge of platform 2 800 mm freight platform: length 2 028 mm width 1 140 mm min. height 500 mm clearance gauge dimension : length 2 720 mm width 1 140 mm height 1 310 mm overall weight with accumulator : 1 500 kg	
Swedish State Railways . .	- wooden barrow capacity 500 kg ball bearings; radius of action 50 m - steel barrow : capacity 1 000 kg ball bearings: radius of action 50 m - experimental: lumber core with wheels of plastic		loading capacity 1 500 kg floor : length 2 200 mm width 900 mm height 340 mm wheels: front pair on revolving ring connected with a drawing bar. At the back coupling device for coupling other trailers; removable gable-walls which can be placed either on short or on long side.			petrol driv tractive po 800 kg length 2 275 width 1 040 radius of gyr 2 700 mi weight 1 15 tyres pneum front 18" × back 23" × engine Volvo, 40 brake: hydr acting on t back whe universal h acting on dr shaft electric eq ment 6 v battery, ger tor and sta motor (see phot fig. 14)

...d truck ...levating ...form	*Roller runway/ belt conveyor*	*Miscellaneous*	*Stationary crane*	*Mobile crane*	*Gantry crane*
...edge of ...orm : ...) mm ...latform: ... 260 mm ...550 mm ...height : ... mm ...of eleva- ...25 mm ...e gauge ...sions : ... 990 mm ...370 mm ... 360 mm ... weight ...cumula- ...500 kg				highest elevation 7-16 m; - *jib cranes with all-round traverse* : diesel and diesel-electric; lifting capacities 2,5-9 ton; volume of grab 1,5 m^3 speed : forward movement 100-207 m/min.; lifting speed : with load with hook 19,5-12,5-7,2 m/min. with grab 58,5-50 m/min. - *automobile crane* : jib span of 2,5-9,0 m capacity 750-5 000 kg; with jacks 2,5-10,0 m; capacity 250-2 000 kg; length of jib 6,2-12,0 m; time rise jib from greatest to smallest span 12-30 sec; height of crane in moving position 3 400-3 575 mm overall length of crane in moving position 8 410-10 300 mm width 2 250-2 700 mm	forward movement of freight 30-30 m/min. freight lifting 8-8 m/min. power electric motion : 20-23 kilowatts - *bridge crane with one hook for medium duty* : capacity 5-10-15 tons; span 11-32 metres; elevation 16 metres; lifting 10-8-8 speed : trolley 40 m/min. crane 80 m/min.

with the exception of the *British Railways* who use slat conveyors and rubber-belt conveyors. The answer of the *Swedish State Railways* shows that there the sorting-problem is approached from the other side. They namely say that it should be tried to reduce the number of permanent sorting-points and instead of this convey the goods as far as possible on a pallet straight from the receiving point to the outgoing wagon. This is facilitated by the increased use of pallets by the railway user and a consequently increased number of transports in an unbroken chain from producer to consumer. Also the *Netherlands Railways* try to solve the sorting problem by less sorting. Only 25 % of the goods for transport still go via the sorting-place. Thanks to direct palletizing at the acceptance doors, the goods are directly conveyed to the wagon. This has become possible by the co-operation of the clients, who tender their goods sorted as much as possible per « group-headstation ». Also clients who tender their goods palletized save the *Netherlands Railways* costly sorting handlings.

The *Soviet Union Railways* use electric trucks on the sorting platforms for conveyance and forklift trucks for conveyance and lifting.

d) Review of equipment.

Equipment to facilitate and accelerate the operations of sorting or conveying the parcels within the shed.

	Sorting	*Conveyance*
Swedish State Railways .	No mechanical aids. The sorting units are placed as near the unloading point as possible and the goods are carried to the sorting unit or conveyed on a wheelbarrow or hand fork truck.	Forklift trucks, hand fork trucks. For distances longer than about 150 m, trailers should be coupled to fork lift trucks.
Soviet Union Railways .	Two or three electric trucks on sorting platforms fork lift trucks. No other equipment.	Forklift trucks. Electric trucks. For greater distances trailers in addition to platform trucks.
South African Railways .	No mechanical equipment.	— Trains of trolleys pulled by a tractor. — Various mechanical conveyors including a slat conveyor built into the platform.
New Zealand Govt. Railw.	No special methods.	In one modern shed trains of trolleys pulled by a tractor.
Eireann Railways	—	Stillages in conjunction with Collis hand trucks.
American Railroads . . .	No special equipment.	Tractor-trailer method at a few stations.
British Railways	Slat conveyor, rubber belt conveyor.	Power trucks - stillages worked with elevating trucks. Internal cartage units.
Netherlands Railways . .	No special equipment.	Forklift trucks, electric trucks with trailers.

e) Number of men, performances and cost.

Very few Administrations are able to state the performance per man/hour. The *Soviet Union Railways* report that the output of fork lift trucks amounts to 5 tons an hour and that the output of the cranes varies from 15 to 20 tons per man/hour.

The staff of the *Indian Railways* handle 7 to 10 tons of goods in an eight-hours shift, which is the equivalent of approx. 1 000 kg per man/hour. Just as the Indian Railways the *Netherlands Railways* have not expressed their performance per piece of equipment either, but for the total handling of the goods. For an average depot this performance amounts to approx. 1 200 kg per man/hour.

For work with fork lift trucks the *Soviet Union Railways* have a gang, consisting of one operator and two or three porters and with cranes one driver and one or two porters. The estimated cost of handling one ton of goods is approx. 1.8 roubles; the actual cost lies somewhat higher. The *British Railways* supply further particulars for some facilities :

slat conveyor maximum output	20 tons per hour
rubber belt conveyor average output	10 tons per hour
power truck average output	3 tons per truck
stillages average output . .	3 tons per truck

As a possible means of comparison it is added, that where primary sorting is involved the number of sortings is usually from 8 to 12, but in the cases of a conveyor serving cartage berths directly the number may be greater. The average weight of packages (maximum 1 ton) is 60-70 lbs. No staff is employed for the stationary equipment. The mobile equipment is worked by one driver per machine per shift. As for the cost; interest, depreciation, maintenance and running cost in total average between 11 and 12 % of the capital cost per annum for stationary equipment and between 25 and 40 % (according to hours of duty) for mobile equipment.

2. For handling pallets.

15. — *What is your opinion and what is your experience concerning machines for handling pallets and pallet-crates ?*

a. *Please list the handling equipment used and in particular detail :*

— *their chief characteristics (lifting power, speed of transfer, radius of gyration);*

— *their respective roles and uses.*

In the case of machines with engines, please give the hourly cost of the equipment used (as regards power supply, maintenances and sinking fund) in relation to the hourly rate of pay.

b. *Please state the reasons for your preference as regards the type of engine (internal combustion engines or electric motors).*

c. *How often and to what extent are the handling machines damaged ?*

d. *What improvements would you like the makers to introduce from the point of view of resistance to wear of pallet-movers or fork lift trucks, as well as in their mechanical design and their characteristics (speed, manœuvrability, weight) ?*

e. *For transporting pallets and pallet-crates from department to department do you prefer to use :*

- *— hand or motored pallet-mover;*
- *— fork lift truck;*
- *— a hauled truck taking several pallets?*

What are the respective outputs (hourly transport capacity) and radius of action laid down in these different cases?

16. — b. *In addition, what arrangements are used for the handling of pallets in the trains serving en route stations that only have low platforms?*

Of the Administrations who have replied to this question the *Swedish State Railways,* the *Norwegian State Railways,* the *Netherlands Railways,* the *Soviet Union Railways* and the *American Railroads* already have a more or less intensive handling of goods with the aid of equipment for handling pallets and boxpallets.

At the *South African Railways* palletization is still in its infancy and general palletization of traffic has not yet been attempted.

The *New Zealand Government Railways* are making trials with pallet transporters but have not yet acquired sufficient experience to go into this question further. The *Eireann Railways* have only one fork lift truck.

The *British Railways* are adapting their sheds to modern working-methods and have started to use pallettrucks as well.

Throughout transport of palletized parcels traffic has not materialized in Great Britain.

The *Swedish State Railways* began to use pallets in 1940. As is the case at the *Netherlands Railways* at present all larger and medium-sized depots are equipped with forklift trucks and handfork trucks and the smaller depots generally have handfork trucks. At the *Swedish State Railways* handfork trucks are also carried in the local goods trains serving the smaller stations. That it is not easy to introduce palletization and reach optimum results is shown by the observation of the *Swedish State Railways* that in spite of an experience of years the organization still is not perfect. Various difficulties, such as a lack of space and a certain moment of inertia in the adaption of new working-methods are the underlying cause. The adaption and follow-up of working-methods are therefore still going on at the different depots.

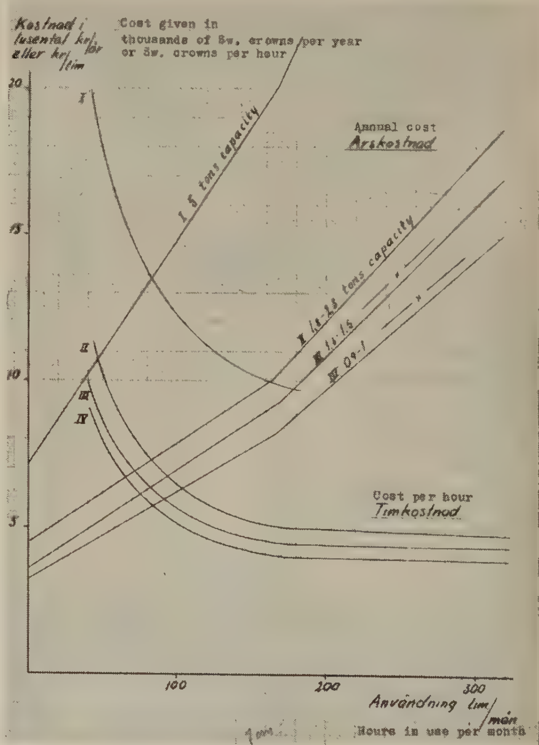


Fig. 12.
(III - B - 2 a)

a) Specifications.

Swedish State Railways. — In use are a total of 193 forklift trucks of different makes and with different capacities. Of these 165 are used in the goods depots. The type of forklift truck that has proved most suitable for shed work is the Hyster QN-ZO.

Of this type the following data are supplied :

lifting capacity	900 kg with 380 mm centre of gravity distance
length without forks	1 800 mm
width	940 mm
external radius of gyration	1 700 mm
driving speed	22 km/h
lifting speed	17 m/min
weight	1 640 kg

This truck is three-wheeled, which, according to the Swedes, is of great importance in connection with driving on gangways and through wagons and for use in the older depots lacking space. It has also a low overhead clearance for the rider when seated (940 mm) which facilitates the use in older goods wagons with low doorways. Besides nearly 1 000 hand-fork trucks of 2 000 kg and 1 200 kg are in use.

In diagram (fig. 12) the annual and hourly cost of various kinds of forklift trucks can be read. As regards cost the *Swedish State Railways* add that in order to be allotted a forklift truck for pallet handling, a depot must show a reduction in staff which equals the annual truck cost. It naturally is impracticable to supply a general rule for the introduction (or non-introduction)of a forklift truck. With the present relative cost this means in Sweden, that a forklift truck is employed if the reduction in the number of workdays per year is calculated to correspond with at least ½ man. It is added that if this relatively low reduction cannot be reached, but pallet transports are sufficiently frequent, the shed is as a rule allotted hand fork trucks.

Soviet Union Railways. — Preference is given to accumulator trucks with a weight of 0.75 - 1.5 tons. These machines justify themselves economically by a yearly output of 8 - 10 thousand tons and higher.

The more specific data of the 0.75 and 1.5 tons forklift truck are :

Lifting capacity	0.75 ton	1.5 tons
Maximum elevation forks	1.6 and 2.8 m	2.75 and 1.5 m
Elevation speed of forks :		
unloaded	16 m/min	8.5 m/min
loaded	10 m/min	5.5 m/min
Maximum speed :		
unloaded	10 km/h	7.5 km/h
loaded	8.5 km/h	6.5 km/h
Minimum radius of gyration	1 550 mm	2 100 mm
Clearance	60 mm	60 mm
Overall weight	1 660 kg and 1 720 kg	2 800 kg and 2 650 kg
Dimensions of forks :		
length	750 mm	950 mm
width	100 mm	150 mm
thickness	25 mm	35 mm

The cost per hour of this truck is approx. 14 roubles, composed as follows :

rider's wage, about	10 roubles
cost of electric current	1 rouble
expenses for sinking fund and all aspects of repair	3 roubles

For the conveyance of one ton of goods over a distance of 100 m 0.5 kW is consumed (drawn from the mains).

Eireann Railways. — The Eireann Railways supply the following particulars concerning the employed Lansing Bagnall Electric pallet-truck :

— rider operated;
— hydraulically operated elevating forks:

long	36″
wide	27″
— capacity	2 tons
— forks from ground	3 1/2″
— lift	7 1/2″

The total hourly cost of the power truck is approximately one shilling. The hourly rate of pay for a porter of three shillings may serve as a means of comparison.

American Railroads. — At this Administration pedestrian- and rider-controlled pallet trucks and pedestrian- and rider-controlled forklift trucks and handfork trucks are in use. Further particulars are not given.

British Railways. — At the British Railways there is a tendency to give preference to pallet trucks with their greater carrying capacity and improved reliability. The use of forklift trucks for pallet conveyance in parcels depots is not generally favoured. From this might be concluded that the pallet equipment is only used for conveying the goods and not to load or stack them somewhere (in shed, road vehicle or wagon).

Particulars of the equipment in use are:

pallet truck:	
capacity	1 ton to 2 tons
speed:	
rider controlled	5 m.p.h.
pedestrian controlled	3 1/2 m.p.h.

radius of gyration: with 90° steering lock, able to turn in own length, which is dependent upon length of forks.

These trucks are only used as a means of conveyance between wagons and road vehicles. For depots where the conveyance distance is in excess of, say, 200 feet, rider-controlled trucks are preferred, and pedestrian-controlled in other cases. As for the cost the British Railways state, that with power-driven equipment of this type the annual interest, depreciation, maintenance and running cost is an average of 25 and 40 % of the capital cost, according to length of working period.

Norwegian State Railways. — Forklift trucks of 0.9 - 2 tons with petrol combustion engines are used. As a reason for this is given that these are lighter, faster and more powerful. Handfork trucks with a carrying capacity of 1 200 kg are also used. No further details were supplied.

Netherlands Railways. — The experiences with forklift trucks at the Netherlands Railways are quite satisfactory. So far only Clark forklift trucks equipped with petrol or diesel engines are used.

The main characteristics of this truck are:

lifting power	1 000 kg
dead weight	1 900 kg
max. speed forward low	6.6 km/h
max. speed forward high	13.2 km/h
max. speed reverse low	5.6 km/h
max. speed reverse high	11.4 km/h
floor clearance	76 mm
radius of gyration	1 650 mm
height of lift	1 870 mm

These forklift trucks are used for conveying the boxpallets and pallets and for stowing them in the wagons.

In depots where the average distance of conveyance averages less than 50 m *handfork trucks* are used, because these are cheaper for such distances.

Principle data of this handfork truck are:

lifting power	1 200 kg
dead weight	129 kg
length of forks	1 125 mm
overall width	720 mm
overall length	1 465 mm
height of fork:	
down	90 mm
raised	215 mm
wheel diameter:	
front	85 mm
rear	200 mm

b) Reasons for preference as regards the type of engine.

The answers of a few Administrations show that experiments with different types of forklift trucks are still being made. The struggle which is going on concerning the

use of electric trucks or trucks with internal combustion engines is developing in favour of the trucks with internal combustion engines.

The forklift trucks used at the *Swedish State Railways* are petrol driven. For various reasons trials with electric trucks were made. These, however, did not come up to expectations. The most important disadvantages with these trucks were :

— the operative period of the batteries between chargings is too short for the intensive use required in a depot;
— the electrically driven truck is not so fast as a petrol-driven truck;
— the rider's seat of the trucks tested so far is too high for these to be accepted in the depots.

In view of the above, the truck with internal combustion engine is so far considered superior to the electrically driven truck and consequently the *Swedish State Railways* for the present and probably also for the near future prefer to use the former.

As regards the alternative diesel and petrol driven trucks : the latter are considered preferable in Sweden. For the Swedish State Railways the initial cost is lower and their life proves to be so long that this is considered not to be outweighed by the lower operational cost of the diesel truck. Also the *Soviet Union Railways* have experimented with several kinds of trucks. At these it appeared that greater efficiency is obtained by the use of the petrol engine as compared with accumulator trucks. This was explained by the lower cost of the internal combustion engine compared with battery and electrical equipment. In these calculations the cost of building a battery recharging shop was also taken into account. The disadvantage, however, was that the small gauge trucks with internal combustion engines have not as yet been found applicable for use within closed wagons, in view of the fact that no system has been evolved for neutralizing the harmful effects of the exhaust gases.

The *Eireann Railways* report that their preference of the electric truck compared with a truck with internal combustion engine was due to the following undesirable features in the latter which, in their opinion, more than offset the slightly cheaper initial cost :

— noise and vibration;
— fumes with attendant danger of contamination;
— oil deposits left on floors and general danger of damage to goods by contact with these deposits or the greasy parts of the truck itself.

These same disadvantages are also mentioned by the *British Railways* explaining their preference for battery-driven mobile equipment.

The *Netherlands Railways* as well are hindered by the exhaust gases of the petrol engines in a forklift truck, which might present a danger for the rider.

The diesel engines have only a nasty smell. In spite of these disadvantages the Netherlands Railways are only equipped with petrol or diesel forklift trucks (the diesels being by far in the majority) because so far no electric truck has been found with a battery of sufficient capacity for an eight hours' shift.

It appears from the reply of the *American Railroads* that at these Administrations too preference is given to electric trucks. In America the trend in recent years is to purchase electrically powered equipment in preference to internal combustion equipment.

The *American Railroads* produce the reasons which hold for the various Administrations : practically noiseless, emit no fumes and while the initial capital expenditure is higher, the equipment lasts much longer and is a great saving in maintenance.

If the *Norwegian State Railways* also have made trials with electric forklift trucks is not known; they say, however, that having to charge the batteries will make it more difficult to use electric forklift trucks.

c) Damage to the handling equipment.

In so far as an answer was given, reactions to this part of the question varied widely.

The *Soviet Union Railways* for instance only mention the platform trucks and say hereof that serious damage has not been met with in the course of work. Experience gained in Russia shows that platform trucks last 7 to 8 or even more years. Besides they require only slight maintenance and major repairs during that time.

The *Eireann Railways* have about one year of experience with the power truck and during that period it has gone out of order only once as a result of the rubber tyre coming loose from the drive wheel.

The observations of the Netherlands Railways and the Swedish State Railways, however, sharply contrast with these favourable judgements.

The *Netherlands Railways* say that the trucks are often damaged and sometimes very severely. In quite a number of cases they have fallen off the platform. In other cases the forks collided with heavy boxes with damaged tilt cylinders and differentials as a result.

The *Swedish State Railways* have experienced that more damage than may be considered normal has been sustained by the steering equipment and the braking-system and by the pneumatic tyres on the steering wheels of a forklift truck of a certain make and by the gear box and the crank axle of the engine in forklift trucks of another make.

The *British Railways* only say that pallet trucks are more susceptible to damage than power trucks.

d) Improvements in the equipment.

Wishes as regards the improvement of existing equipment practically always remain. If one wishes to improve a certain system, often the equipment will have to be adapted also. The few Administrations who have replied to this question consequently could not escape this necessity either.

The wishes of the *Swedish State Railways* and the *Netherlands Railways* in general run parallel. Both Administrations are still looking for an electric truck with performance and data almost identical with the types now employed and with a longer operational time between two battery chargings than of the present electric truck. If it were possible to procure such an electric forklift truck at a reasonable price, this would be preferable for the depot work to a truck with internal combustion engine. Besides this electric truck the *Swedish State Railways* are looking for something for their smaller depots, which might be described as a powered pallet lift truck. The pallet trucks that have been tried were not suitable because these do not surmount the differences in level which generally exist between platforms and wagons. The pallet trucks are, moreover, so expensive, that it is often more economic to procure a forklift truck. A cheap motor-driven pallet lift truck would, also in the opinion of the *Netherlands Railways,* facilitate the handling of pallets at smaller stations and might also be a suitable auxiliary aid in depots where at present forklift trucks are used for internal conveyance.

The *Soviet Union Railways* are of an opinion that their platform trucks from the point of view of their use for loading and unloading pallets in covered wagons are in serious need of improvement, such as increased manœuvrability, decrease of weight, improvement of conditions for the operation and the provision of preventive equipment against overloading.

The *Eireann Railways* are very satisfied with the truck they employ. In view of the rather big dimensions of the stillages the standard forks of 36″ are replaced by forks of 48″.

The *British Railways* only say that they

consider the general design of the pallet-trucks unsuited to normal parcels operations.

e) Choice of equipment for the internal conveyance of pallets; performance.

The *Swedish State Railways* are of an opinion, that operation with forklift trucks is the prevailing method. The handfork trucks are used as a complement to forklift trucks or to wheelbarrow conveyance.

The Swedish State Railways do think, that for longer distances forlift trucks and trailers should be used, but in view of the available space this cannot be put into effect. The performance is subject to the distance to be bridged, relative freedom of passage, organization of the work, etc.

To illustrate this, data have been collected in two depots :

	Average length of conveyance.	Average number of parcels per pallet.	Average number of conveyed parcels per truck/h.
transhipment shed	125 metres	6	75
local and transhipment shed	80 metres	10	85

At the *Netherlands Railways* conveyance is also principally performed with forklift trucks. Only in one large shed also electric trucks with trailers are used. Conveyance at very short range is performed with handtrucks. Performance data of conveyance only cannot be given because besides conveying the forklift trucks also execute the loading in the wagons. Of the means of conveyance : hand or powered pallet truck, forklift truck and a hauled truck taking several pallets, — mentioned in the question — the *Soviet Union Railways* prefer the forklift truck. Performances of the forklift truck are not supplied, but of the platform truck without trailers it

Fig. 13.
Swedish State Railways : Trailers for unloading containers (III - B - 2 f).

is reported, that at an operating distance of 25 - 100 m the output attains about 16 - 25 tons an hour at a lifting capacity of the machine of 0.75 tons and 27 - 40 tons an hour at a lifting capacity of one ton.

The *British Railways* give as their view that power-operated pallet-trucks are more economic than other types of appliance in depots where pallets are used. Hand pallet trucks are occasionally used for very short distances. Conditions are so varied that no reliable information can be furnished as to output.

The *Eireann Railways* have preference for a powered pallet truck.

f) Equipment for handling pallets on low platforms.

Replying to the latter part of question 16, the *Swedish State Railways* say that in respect to ordinary parcels traffic, this question is not relevant to Sweden, as this traffic is loaded and unloaded exclusively on and from high platforms. This problem does arise, however, in connection with the transport of fast traffic to intermediate stations. To unload this traffic, the Swedish State Railways use handfork trucks and forklift trucks. Goods to and from intermediate stations with low platforms are, however, as a rule loaded in small containers, provided with wheels and therefore easy to move. To unload the containers trailers are used with floors which can be elevated and lowered. The type shown in figure 13 is now being procured.

The *American Railroads* say that no pallets are handled in wagons of trains serving en route stations.

CHAPTER IV. PROBLEMS INHERENT IN DISTRIBUTION (*).

1. Vehicles and other equipment.

17. — *In the large towns, are the vehicles used for collection and delivery at clients' premises of special kinds according to the nature of the traffic? (small parcels, ordinary parcels, very heavy parcels).*

What equipment is used to make it possible to collect or deliver heavy parcels to clients who have no loading platform (large units, pallets, small containers).

From their replies it can be concluded that following Administrations have no own collection and delivery service :

— the *East African Railways, Indian Railways, New Zealand Government Railways, Soviet Union Railways* and the *Swedish State Railways.*

In these cases collection and delivery are left to contractors, local carriers or to a special « motor-transport organization » (Soviet Union Railways).

At the *East African Railways* a collection and delivery service, however, is on the programme.

In one individual case (Indian Railways) it is mentioned that the contractors use motor vehicles for the transport of packages from and to the railway.

The other Administrations do not mention the character and kind of vehicles, used by the contractors, local carriers, etc.

At the Administrations who do possess collection and delivery services of their own, viz. the *British Railways, Eireann Railways, Malayan Railway, Netherlands Railways, Norwegian State Railways* and the *South African Railways* there still remains a great difference in the kinds of vehicles, the services rendered and the accommodation the clients are supposed to have (loading platform, etc.).

a) Vehicles.

The *Swedish State Railways* as a rule use ordinary lorries, in the centres of

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(*) *By distribution should be understood the operation of collection from and delivery of parcels to client's premises.*

larger cities, however, horse drawn vehicles are often used, as these can move about more easily there. For the collection and delivery of heavy parcels lorries equipped with cranes are employed.

The *South African Railways* have purpose-built covered parcels lorries for the delivery/collection of small parcels which are normally confined to city centres. Heavy parcels are picked up and collected with semi-trailers with carrying capacities varying from 5 to 10 and 15 tons. These semi-trailers are placed at the client's for loading or unloading and no railway personnel is in attendance whilst this work is done. Ordinary consignments are usually delivered and collected by semi-trailers while straight loads comprising commodities such as sugar, cement, etc. are delivered by rigid vehicles with a 5 tons carrying capacity.

The *British Railways* have as standard equipment small semi-trailers of 3 tons. These are mostly not covered as reporter thinks to be able to derive from the observation that « Special covered trailers are provided for parcels susceptible to damage by wet ».

At the *East African Railways* measures are taken for the organization of an own collection and delivery service; provisions have been made for the use of articulated vehicles. Trailers will mostly be of 3-tons and 6-tons capacity with a small number of special trailers, e.g. drop frame, semi drop frame and pole trailers for special loads.

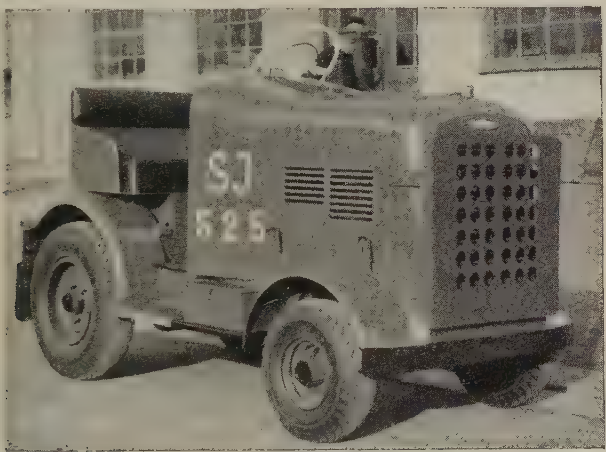

Fig. 14.
(III - B - 1 a, list)

The *Netherlands Railways* for normal goods make use of covered vehicles with a load capacity of 1 ½ tons (fig. 15). For goods, which owing to their volume or weight cannot be carried in these vehicles, lorries of 4 tons capacity, also covered, are employed; uncovered vehicles of larger sizes with capacities of 4 and 5 tons are used for collecting palletized goods; these lorries are covered with tarpaulins, if necessary (fig. 16 and 17). This is done for those clients who take part in the pallet exchange.

The *Eireann Railways* have general purpose vehicles suitable for all types of

Fig. 15.

Van Gend & Loos. Commer 1.5 t. 8.5 m³ (approx. 300 cubic feet) nett delivery van at Amsterdam depot; 375 of these were put into service in 1957, another 150 will follow in 1958. (IV - 1 *a*)

Fig. 16.

Van Gend & Loos. DAF A 1 300 C 406 lorry (petrol engine, 4 3/4 t in VGL - service) for collection of palletized consignments (IV - 1 a, V - B - 4 b).

Fig. 17.

Van Gend & Loos. DAF A 1 100 C 406 lorry (petrol engine, 4 1/2 t in VGL - service) with 1 t crane of S.A. Etablissements Cl. Bonnier, Courbevoie (Fr.), for collection and delivery of palletized consignments (IV - 1 a, V - B - 4 b).

Fig. 18.

Van Gend & Loos. DAF A 1 100 C 406 lorry with 1 1/2 t hydraulic crane of Forslund & C°, Skellefteå (Sweden), for collection and delivery of palletized consignments and heavy packages. The crane jib is made of flat oval telescopic tubes; lifting capacity 1 500 kg (30 cwts) at 1.66 m (5' 6"), 800 kg (16 cwts) at 2.60 m (8' 6"), 500 kg (10 cwts) at 3.60 m (11' 10"). (IV - 1 a, b; V - B - 4 b.)

parcels traffic. For extremely heavy goods there may be no alternative to providing the services of a mobile crane for which a special charge is made.

b) Other equipment.

The *American Railroads* have no special equipment as collection and delivery tariffs require the consigner or consignee to have a loading or unloading platform. Also most clients of the *British Railways* have both platforms and equipment for dealing with heavy goods.

Both the *Swedish State Railways* and the *Norwegian State Railways* have equipped some lorries with cranes of 1 ½ tons lifting power. These are very useful for the transport of small containers.

The *Netherlands Railways* as the *Eireann Railways* mostly employ simple appliances such as loading boards, etc. To unload small containers the *Netherlands Railways* use a handwinch.

At present, however, experiments are made with two types of small cranes of French and Swedish make with which small containers can be loaded and unloaded. These cranes are also suitable for loading and unloading boxpallets (fig. 17 and 18).

The *Eireann Railways* in some cases use a two wheeled float with a very low floor though these vehicles, while they are held available at large depots, have only a limited use for general delivery work and are not used as a regular feature.

Neither the *Malayan Railway* nor the *South African Railways* have special equipment. The latter because at their Administration loading and unloading is the client's task.

2. Transfer from shed to cartage vehicles.

18. — *How are parcels transferred from the goods shed to the cartage vehicles?*

Only one Administration and then only very summarily indicates the way goods are tranferred from the shed to the cartage vehicles. At answering question 12, this subject has been gone into further.

a) Synchronization of operations:

a. *Is this operation synchronized, in other words:*
- *does any delay in unloading wagons instantly become an obstacle to punctual carrying out of the delivery service?*
- *inversely, does any delay in the collecting service at once affect the loading and preparatory work of getting the trains ready for despatch?*

At most Administrations this operation is synchronized. Delays in the collection service as a rule do not affect the departure of the trains.

At the *Netherlands Railways* the trains arrive during the night and the goods are mostly delivered at the clients the day after their despatch. Delays at arrival consequently affect the delivery service. In many cases the delivery service makes more than one round a day. Every delay of the trains does not imply that the goods are delivered a day later. The collection and delivery of the goods has not been standardized at the *Swedish State Railways*, but has been organized in accordance with local conditions and resources.

The further reply is based on one of the largest goods depots. The goods are delivered twice a day (by a private firm), as a rule at 8.30 a.m. and 1.00 p.m. Incoming wagons are unloaded between 6 a.m. and 2 p.m. Unloading and delivery are not synchronized, and parcels which are not unloaded in time for the earliest delivery are left for the next one.

The collection of the goods is also carried out twice a day by the same vehicles which deliver the goods and in connection with the delivery. Before leaving the railway shed the delivery man is informed of the addresses at which he is to collect goods.

The loading of the outgoing wagons goes on till 10 p.m. Marshalling begins at 5 p.m. The collected goods are as a rule despatched on the same day. There is no synchronization of the collection of parcels and their being loaded into the wagons.

The loading of wagons at the *Soviet Union Railways* is done in conformity with a « calendrical graph ». The cartage of goods is done well in advance; to ensure this the time of delivery to the goods shed is indicated when the visa is granted for the waybill.

Failure to deliver the goods to the goods shed in time may affect their time of despatch, but not the departure of trains which are made up of other wagons besides those carrying parcels traffic. As a rule such cases do not occur.

The *South African Railways* write that to save kilometres and to avoid that more than one vehicle run to the same client, it is necessary to make up loads in directional order or in zones. This requires that the checkers (depot staff) have a number of empty trailers or semi-trailers available at the depot on which the loads are to be assembled. The consignments are conveyed to the respective vehicles by wheelbarrows. Small consignments destined for clients throughout the city area are collected from the various checkers' sections by depot vehicles and conveyed to a sorting area where they are sorted into zones to obviate light mileage.

To operate the cartage fleet efficiently the work is done with trailers and semi-trailers and the delivery service should at least be one day in arrear of the goods-shed working. Unless this is adhered to, the cartage services cannot be promptly supplied for the reason that « in bond » traffic and traffic received at the depot by rail without covering documents etc. cannot be loaded.

Set times are laid down for drawing loaded wagons from particular sheds in order that trains may be marshalled. This applies in particular to perishable and express traffic and any delay in collecting such traffic from clients' premises must necessarily react adversely on the departure of trains. When daily collections are made, preference is given to perishable and express traffic to ensure that it reaches the depot in good time.

The *Malayan Railway* writes that conveyance from the goods shed to the cartage vehicles is performed with handfork trucks. This operation is not synchronized.

At the *New Zealand Government Railways* this transport is done with wheelbarrows. Heavy lifts may be made by mobile crane, overhead gantry crane, overhead traverser (hand operated) or fork-lift truck. The operations are not synchronized but generally speaking cartage men regulate their operations to suit the availability of loading.

The conveyance of the packages from the shed to the cartage vehicles is done manually at the *Eireann Railways*. There is a good co-ordination between the shed operations and the collection and delivery service and every noticeable delay in the regular flow from either section will have a corresponding adverse effect on the other, which in the one case will turn out in a later delivery and in the other case in a retarded loading of the railway wagons and possibly overdue departure of the goods trains.

At the *American Railroads* both incoming and outgoing operations are synchronized.

British Railways. — Operations of loading cartage units are synchronized with those of unloading the wagons and this is facilitated by the system of pre-loading on semi-trailers. It is clear, they write, that

delay at unloading the wagon has an immediate effect upon the loading of the delivery vehicles.

The method of direct loading ensures that the maximum amount of collected parcels are loaded into wagons, irrespective of time of train departure.

At the *Norwegian State Railways* delay in unloading the wagons is to a certain extent an impediment for a punctual execution of the delivery service. If the delay in the collection service is limited, then this does not affect the operation of trains.

The *Indian Railways* state that in places where the collection and delivery services are performed by contractors, there is an adequate time lag between the unloading of parcels and their removal for delivery and between their arrival at the depot and the time of despatch by train. No special attempt of synchronization has been necessary.

b) Preparations by depot staff.

b. *How are the parcels grouped on the platform by the depot staff in order to facilitate loading them into the cartage delivery vehicles?*

Spreading the goods in zones and storing them on sections according to zone as done at the *Netherlands Railways* is executed in about the same manner by the *Swedish State Railways* and the *South African Railways*, by the *American Railroads* and the *Norwegian State Railways*.

Of said Administrations, the goods are loaded by the drivers in order of delivery round at the *South African Railways* and the *Netherlands Railways*.

The *Norwegian State Railways* do not indicate this but state that the goods are not sorted in delivery order for the delivery vehicles. Here the goods are probably loaded by the drivers as well.

The *American Railroads* reply that at some places the chief despatcher for the delivery company arranges the bills in sequence for loading on the vehicle. At some stations railway employees perform this loading operation; at other stations the lorry-driver assists the railway employees and again at other stations the lorry-driver solely performs the loading operation.

The *Soviet Union Railways* reply that in order to speed the delivery of goods to clients, goods are stored in accordance with the delivery schedule, but in certain cases and in certain regions they are delivered to important clients and city districts.

The *New Zealand Government Railways* reply: parcels are stacked in bays, usually in those nearest to the wagons being worked at. In cases of large volumes of traffic for one consignee, special bays are reserved.

At the *Eireann Railways* the parcels are placed on the shed platform as close as possible to the point for re-loading on to the delivery vehicle but beyond this in the preliminary stacking on the shed platform sorting does not go further than keeping together traffic in large volumes for certain consignees.

At the *British Railways* parcels are not grouped. Pre-loading of delivered traffic obviates grouping of parcels on the platform.

The *Indian Railways* write that packages for the delivery service are separated and kept in one group by the goods shed staff, even while unloading. Further sorting to facilitate delivery is done by the staff of the delivery contractor.

c) Preparations by collection service.

— *Inversely, what preliminary sorting is done by the collection service before the parcels are handed over to the railway?*

In general this question has not been answered very detailed either.

At the *South African Railways* as well

as at the *Eireann Railways* there are several sections in the shed. The collection service has to deliver the appropriate goods at every section. The driver while collecting goods endeavours, as far as possible, to group the sections on the vehicle to correspond with the sections in the goods shed to facilitate unloading.

At the *Swedish State Railways* — on the contrary — there is a special bay in the shed for outgoing goods. Here the driver has to sort the parcels according to sender to facilitate the marking of the waybills.

The *British Railways* do nothing beyond what can be done by driver whilst collecting his load. They do not go into the subject any further.

At the *Indian Railways* and *American Railroads* the driver loads the consignments indiscriminately on his vehicle. The *American Railroads* further add that upon arrival at the station, the bills are turned over to railway employees, and here again the unloading of the consignments from the road vehicle may be performed exclusively by railway employees, or the driver may collaborate with the railway employees, or the lorry-driver may solely perform the unloading from the lorry to station platform equipment.

The *Netherlands Railways* accept the goods at one point in the shed. The collection service already groups the goods according to destination (« group-head-station ») as much as possible. In co-operation with the clients this preliminary sorting goes rather far. Within the framework of the pallet exchange which a.o. aims at having the goods undergo fewest possible handlings, it is even necessary that already at the clients the goods are sorted per « group-head-station ». This is done to make the effect as favourable as possible. At those clients where the collected goods are already palletized it is aimed at to load in one box or one pallet only goods for the same « group-head-station » of destination.

There will naturally always remain « miscellaneous » pallets with goods for various destinations. It is tried to keep their number as small as possible as these goods have to be sorted by the shed staff, which means additional work.

The *Soviet Union Railways* reply that sub-grouping is carried out when a visa is granted for the waybill. The days for loading for separate destinations are also fixed at this point. There are also sub-grouping sheds. In the latter the goods are grouped according to destinations under the organizational plan for parcels traffic. Such sheds are scattered about the towns and are served by transport despatch offices.

d) **Loading of vehicles by depot staff.**

c. *If the depot staff also load the cartage delivery vehicles :*
— *is such loading based on a permanent programme or according to the instructions given by the delivery van driver ?*

Only the *British Railways* reply : the depot staff load cartage vehicles according to a permanent programme.

From what the *Soviet Union Railways* write cannot be clearly gathered if loading is based on a permanent programme. They do say that the personnel of the goods shed is employed in loading the goods on the vehicles, but this may also be done by the client. In any case railway checkers ensure the correct disposal of the goods. The drivers are responsible for the correct positioning of the goods in the vehicles if they at the same time act as consigners or specialized agents for the clients.

At the *South African Railways* and also at the *Netherlands Railways* small consignments are not loaded before the documents are sorted in round's order. At both Administrations large consignments are loaded by shed personnel though reporter is inclined to think that this

more often occurs at the *South African Railways* than at the *Netherlands Railways.*

At the *South African Railways* each checker is supplied with a map of the town or city on which the loading zones are indicated. Checkers load the semi-trailers in accordance with these zones.

The *Eireann Railways* observe that : Staff engaged on this type of work generally have long experience and though it is true in the final analysis to say that the loading of vehicles is according to the instructions of the driver, in fact the work is expedited by the preliminary sorting on the shed platform and in the selection of items for delivery by the shed platform staff who assist the driver in the actual loading. The *Swedish State Railways* reply that the railway staff assist the road carrier with loading and unloading according to his instructions. And at the *Norwegian State Railways* the goods are loaded by the driver and his assistant.

> — *or again, if the shed staff does not load according to a definite programme, is the loading done in such a way that the driver can control the loading by sight (for instance by spreading the parcels in a single layer on the floor of the vehicle) ?*

Except from the *Netherlands Railways* no replies have been received. This question naturally does not apply to all Administrations but apart from that it is possible that difference of opinion prevails about « permanent programme ».

At the *Netherlands Railways* this question only has reference to very large consignments which are loaded direct on the road vehicles by the shed staff. If these consignments consist of many packages, control by the driver is scarcely possible.

3. Checking by the driver.

> 19. — *How are the invoices, waybills and other documents sent ?*

On account of the confusing translation of the French « transmis » into « sent » partly replies were given which are not to the point here.

> — *Does the driver check the parcels by this means, especially when the cartage delivery vehicles are loaded by the shed staff ?*

A few Administrations enter somewhat further into this question and in short tell something of the clerical work. The *Swedish State Railways* reply : While unloading the railway vans the goods are checked against the consignment notes. The parcels to be delivered are deposited in a place intended for the purpose. The consignment notes are sent to the station office where the freight and other charges are checked or calculated and entered on the consignment note. The charges due to the road carrier are entered on a slip in two copies. One copy of the slip with the corresponding consignment notes is given to the road carrier, the other copy of the slip is kept by the railway.

At the end of his delivery shift the road carrier's driver hands over the sum cashed to his firm who in their turn send the railway a cheque for the amount. The road carrier's slip, receipted cons. notes, possible unreceipted cons. notes and goods which could not be delivered are returned to the railway and checked against the railway's counterslip. At transfers between the Railway and the Road Carrier goods and consignment notes are always checked with each other in the presence of representatives for both parties.

The *Soviet Union Railways* reply to this question :

If the tare is in good order, the goods are handed over to the consignee or his agent according to the number of packages without checking the weights. If it is found necessary to check the number of packages or the condition of the tares this is done in the depot by the consignee before loading on the vehicles.

At the *South African Railways* full trailer loads for one consignee are loaded

in the absence of any driving personnel and when they are delivered, the driver obtains a « not checked » receipt from the client. It is the client's responsibility to advise the depot of any discrepancy within a stipulated time. In so far as semi-trailers are concerned these are loaded in the presence of the driver and each parcel is checked by him on delivery or collection. In regard to « city smalls » these are also checked in and out of vehicles by the driving personnel.

The *Netherlands Railways.* If a delivery vehicle is loaded by the shed personnel (large consignments) a check with the documents in most cases is not possible.

If the delivery man performs the loading himself, he loads the goods in order of the documents. At the *Eireann Railways* a separate delivery docket for each consignment is prepared from the invoice at the receiving station, and a delivery sheet is prepared from the dockets for the consignments loaded. The invoices are never used by the driver as a check on parcels loaded on delivery vehicles.

At the *American Railroads* the lorry-driver is provided with the delivery receipt and the freight bill for consignments in delivery service, and he checks the parcels when delivered to the consignees from these documents.

As the Swedish State Railways, the *Indian Railways* also have a contractor for the delivery of the goods. With regard to delivery of consignments at client's premises by the contractor a delivery sheet is prepared by the shed staff, two copies of which are handed over to the representative of the contractor who, in some cases, is the driver of the cartage delivery vehicle and, in others, a separate person accompanying the vehicle. The representative of the contractor takes over the consignments for delivery, after tallying them with the delivery sheet. The contractor collects the freight and the railway receipt before delivering the consignments and obtains the signature of the consignees in the appropriate column of the delivery sheet. One copy of the delivery sheet, along with the collected railway receipts, is handed over at the shed at the close of the day. The money collected is remitted by the contractor at the depot or into a bank, as mutually arranged.

At the *Malayan Railway* and the *Norwegian State Railways* checking of goods and waybills as a rule is done by the driver.

At the *British Railways* the driver accepts the load as prepared by the platform checker.

4. Apportioning of responsibility between shed staff and delivery service.

20. — *How is responsibility apportioned in the case of loss or damage?*
Does such apportionment depend on the formula adopted for the transfer of the parcels?

This question has been interpreted differently. Most Administrations have understood the question to concern the Administration's liability towards third parties (consigners, consignees, contractors for the collection and delivery service). The meaning was: the apportioning of responsibility between the shed staff and the staff of the collection and delivery service. This meaning could have been understood by the fact that the question was entered in Chapter IV and its consequent connection with the preceding questions, in particular the latter parts of questions 18 and 19. As in substitution of « Administration's own staff », « the contractor » may be read, besides the answer of the *Netherlands Railways* only those of the *Indian Railways* and the *Swedish State Railways* can be considered for mention.

At the *Netherlands Railways* in general the delivery-man himself is responsible if damage or loss were not perceived at loading. If the delivery man has not performed the loading himself (pre-loaded large consignments) then owing to the

impossibility of control at taking over by the delivery man, nobody can be held responsible.

The *Indian Railways* reply that in the case of consignments collected by the contractor from clients' premises for booking by rail, these are checked by the shed staff before being taken over from the contractor and any damage, etc. noticed at this stage becomes the contractor's responsibility.

As regards consignments delivered by the contractor at the clients' premises, the contractor, when taking these over from the shed staff, checks them and ensures that particulars of damage, shortage, etc. are duly entered in the delivery sheet. The contractor is responsible for any shortage, damage or loss, other than that entered in the delivery sheet.

According to the rules of the *Swedish State Railways :* the party who has received the goods is responsible for same. For visible damage to goods, the party who has received same without protest, is responsible.

CHAPTER V.

PROBLEMS CAUSED BY THE GENERAL PALLETIZATION OF THE PARCELS TRAFFIC.

A. General.

1. Application of pallet-systems.

21. — *What is the present position of your Administration as regards palletization? Give details concerning the volume of equipment concerned (number of pallets, pallet-crates, pallet-movers, forklift trucks, etc.).*

a) Present position.

As every mechanization of operations is influenced by the ratio between the levels of wages and prices, at the introduction of palletization by the Administrations the ratio between the cost of a man/hour and the cost of a forklift truck plus pallets per hour will also have been a subject of consideration. Palletization might therefore be expected to have advanced farthest in countries with a relatively high wage level, in other words with a high standard of living. Such expectations prove to be only partially realized. Wholly in accordance with these are the replies of the *Indian Railways,* the *Malayan Railway* and the *East African Railways,* that goods are not transported palletized by their Administrations. The latter Administration consequently points out that at the present relatively low cost of labour, employment of mechanical handling equipment cannot be economic. In the more industrialized countries, on the contrary, palletization has been worked upon or is thought of, but general palletization has been reached scarcely anywhere.

As already mentioned in the questionnaire, general palletization is understood, above all, to be palletization covering the whole chain of transport from one end to the other and including as far as possible both consigners and consignees.

The *New Zealand Government Railways* have recently commenced trials with palletization. In South Africa palletization is (as yet) in its infancy, as is stated by the *South African Railways,* at which Administration general palletization of traffic has not yet been attempted. However, in this country palletization of cargo in harbour sheds has been in vogue for some time; palletization begins and ends there at unloading respectively stowing in the hold of the ship. The transportation by rail of pallet loads is chiefly confined to traffic from and to private sidings. Besides, palletization is practised at certain inland transhipment depots in order to conserve stacking space and to ensure a quick release of wagons.

The *Soviet Union Railways* state to have examined three variants of the use of pallets for facilitating and speeding up the transport and sorting of parcels traffic.

These three variants are :

variant 1 : transportation on pallets covering the entire distance from consigner to consignee;

variant 2 : transportation on pallets from consigner to and included storage in the railway shed, stowing in the wagon and transport without pallets, and transport on pallets from wagon to consignee;

variant 3 : delivery of the goods to the despatch depots without pallets, placing these on pallets for storage at the time of acceptance until the loading into wagons, transportation of the goods in the wagons without pallets (« by existing methods »), placing on pallets on unloading for storage on same. until distribution and delivery of the goods to consignee without placing on pallets.

The first variant, i.e. general palletization, was admitted to be the most expedient and is gradually developed, but is not yet widely used. The third variant is usually adopted in the majority of railway sheds. The clients also use pallets and forklift trucks in their warehouses, in some cases in far greater numbers than in the goods depots. Palletization at the *Soviet Union Railways* still is, however, of an experimental character.

It is efficient for the further description of the present position to mention a fourth variant here, which at some Administrations makes up the principal form of pallet use. Reporter would like to describe this as follows :

variant 4 : palletization of the packages on acceptance in the forwarding sheds, conveyance in the sheds and transportation in the wagons on pallets and delivery of the goods to consignee without the use of pallets.

At the *British Railways* the above-mentioned variant 1 is only exceptionally put into practice, although facilities are offered to traders for conveyance by rail of parcels on pallets. A small amount of goods are carried on flat pallets or in boxpallets for part of the journey either by rail or road where it is advantageous to do so. At some 40 goods depots variant 3 is practised so with pallets as a medium of conveyance between wagons and cartage units.

The *Eireann Railways* state not to have embarked upon a palletization programme. At the *American Railroads* every railroad is equipped to handle palletized traffic. Though the railroads encourage palletization, very little tonnage is handled according to variant 1. Besides, as mentioned in Chapter III, conveyance in recently built sheds is mechanized by the American Railroads by means of overhead or underfloor chain conveyors.

The *Norwegian State Railways* use pallets exclusively for conveyance in and transportation between the sheds, conformably to variant 4. At this Administration the pallet was introduced in 1949. From the reply of the *Swedish State Railways* can be gathered that variant 1 is seldom practised though palletization as a means of internal conveyance has been in practice on a large scale upwards of ten years. Variant 4 predominates instead.

The pallets are not stacked in the wagons but are nearly always loaded in one layer. In Sweden there is, however, a great interest in palletization, which is demonstrated by the use of approximately one million (flat) pallets in this country only. In view of this and of the growing interest in the use of the pallet in the unbroken transport chain and in the formation of pallet pools the Swedish State Railways expect a markedly increasing use of pallets also for external transport.

Of the Administrations from whom replies have been received, the *Nether-*

lands Railways together with the *Swedish Railways* have proceeded farthest with general palletization. At the former who, as mentioned earlier, have charged their subsidiary company Van Gend & Loos with the handling of parcels traffic, palletization as is the case in Sweden, is the common procedure.

Also in the Netherlands only a small part of the parcels traffic is so far offered for transportation palletized and on arrival is transported likewise from the shed to consignee.

The general procedure is that the parcels, in so far as these are suitable, are palletized at the time of acceptance, and are unloaded from the pallets not earlier than for sorting in the destination depot after which they are delivered unpalletized. The pallets are stacked in the wagons. The number of consigners with whom an agreement for pallet-exchange is entered into is, however, gradually increasing. It will be clear that the more often transhipments have to take place, the greater the advantages of palletized parcels traffic in the wagons will be. At the *Netherlands Railways,* however, transhipment from wagon to wagon is of rather infrequent occurrence, which a.o. is due to the rather great density of traffic. That nevertheless palletization has proceeded farthest at this Administration may have been caused by another circumstance.

Contrary to the advantages as regards the handling of the packages at despatch and arrival is namely the fact that palletized transport entails a loss of loading space. By weighing this disadvantage against the advantages, the *Netherlands Railways* reached the conclusion that upwards of a distance of approx. 300 km, palletization entails such increases of cost that these are no longer balanced by advantages of another nature (see sub C-1). As no greater distances than approx. 300 km exist in the Netherlands Railways' network this consequently is no obstacle for throughout palletization, whereas at the same relative cost this will be the case in other countries.

In this connection, it should be mentioned that the *Soviet Union Railways* replying to one of the questions, say that variant 1 has proved to be cheaper than variant 2 only at distances below 200 - 300 km.

An important factor which strongly affects the loss of space is, as is mentioned by the *Swedish State Railways,* the *Soviet Union Railways* and the *East African Railways,* the differences in the tare of goods, which make stacking in the wagons difficult. The *Swedish State Railways* add that the easily stackable parcels traffic has gone to the competitive road carriers, thus leaving to the railway the greater part of the goods that are not easy to load. This problem once again underlines the necessity for Railway Administrations to be in a competitive position against road transport, for which palletization might be a means (see also sub 2 b).

Of course the *Netherlands Railways* too meet with this difficulty, which is, however, partially solved by the relatively great number of boxpallets they employ in comparison with other Administrations (see sub 2 b).

If we compare the annual tonnages known with the stadium of palletization, it appears that the Administrations with the largest goods traffic all have means of palletization (with the exception of the Indian Railways).

b) Quantity of equipment.

Hereafter follows a survey of the quantity of the equipment in use in so far as data were supplied by the Administrations. In view of the extent of the palletization of parcels traffic as mentioned above, it is probable that in the numbers stated, equipment also used for car load traffic is included.

Administration	*Annual tonnage (see chapter I)*	*Stadium of palletization (variants)*
British Railways	5 000 000	3 in operation in 40 sheds 1 seldom
East African Railways	646 000	no palletization
Eireann Railways	450 000	no palletization
Indian Railways	4 842 000	no palletization
Malayan Railway	100 000	no palletization
Netherlands Railways	1 398 000	1 occasionally 4 common method
New Zealand Govt. Railways . .	494 000	trials commenced
Norwegian State Railways . . .	(12 % of total tonnage)	4 common method
Soviet Union Railways	4 970 000	principally 3 1 and 2 seldom
Swedish State Railways	1 246 000	1 occasionally 4 common method
American Railroads	7 000 000	2 and 3 possible, 1 seldom

Administration	*Year*	*Number of pallets*	*Number of boxpallets*	*Number of forklift-trucks*	*Number of handfork-trucks*
Netherlands Railways.	1957	25 000 3 000(*)	10 500 200 (*)	110 12(*)	330
Norwegian State Railw.	1957	20 000	50.	30	250
South African Railways	1957	13 900 3 500(*)	—	150 68(*)	?
Soviet Union Railways	—	up to 1 500 p. station	?	up to 15 p. station	?
Swedish State Railways	1957	78 000 14 000(*)	2 000	193 30(*)	1 000

(*) Ordered, not yet delivered.

A general view of the types of forklift trucks and handfork trucks is supplied by the following table :

Administration	*Forklift trucks*		*Pallet trucks*		*Handfork trucks*
	Type	*Capacity*	*Type*	*Capacity*	*Capacity*
		kg		kg	kg
Netherlands Railways.	rider controlled diesel	1 000	—	—	1 200
Norwegian State Railw.	rider controlled petrol	900	—	—	1 200
American Railroads .	pedestrian and rider controlled	?	pedestrian and rider controlled	—	?
South African Railways	?	?	—	—	—
Soviet Union Railways	rider controlled electric	750 1 500	—	—	—
Swedish State Railways	rider controlled petrol	900	—	—	1 200 2 000
British Railways	—	—	rider and pedestrian controlled	1 000 2 000	—

The data concerning the dimensions of the pallets etc. are supplied sub B.

From the above it is clear that the East African Railways, the New Zealand Government Railways, the Ceylon Government Railway, the Indian Railways, the Eireann Railways and the Malayan Railway have supplied no further particulars about palletization as they do not apply this system. The *South African Railways* for the same reason only supply further particulars of the kinds of pallets used at some places.

2. **Results.**

22. — *Have you made out the financial balance sheet for palletization, taking into account the savings made in staff and capital invested (purchase of the equipment or alterations to existing fixed installations), as well as certain additional operating costs relating, for example, to the additional weight to be carried, the allocation and return journeys of empty pallets, a possible reduction in the average load carried in the wagons, etc?*

— *Is the balance sheet obtained from a prior study or from practical results?*

— *Can you mention any other advantages, giving figures if pos-*

sible (for example, reduction in damage, improved journey times, better position from the competitive point of view, possibility of recovering lost traffic, etc.)?

a) **Economic results.**

The *American Railroads* and the *British Railways* say that no financial balance sheets for palletization have been made. This is only natural, as these Administrations have not applied general palletization as a system, but as appears from the above consider forklift trucks and pallets facilities for handling parcels traffic in the sheds, in those cases that the service to the client or the character of the goods to be despatched renders their application desirable.

One is inclined to expect that Administrations who apply palletization on a larger scale, do such either also as a result of a preceding research into the economic results to be expected, or that they have at least afterwards investigated its final effect on the cost of parcels traffic.

The *Norwegian State Railways,* however, did neither of the two. They report that « palletization was introduced in 1949 on the basis of experience gained by other Administrations », apparently on the assumption that the supposedly favourable results at those Administrations would also be reached by them. In addition they say that as yet they do not know the exact economic results of palletization.

The *Soviet Union Railways* are more positive in their reply. They write that the special ratio in the use of pallets was fixed when the three palletization variants (see 1-a above) were examined. All factors enumerated in the question were taken into account.

From investigations, particulars were derived which could serve as a basis for calculation. These showed that the adoption of pallets in conjunction with forklift trucks decreased the amount of work necessary for loading or unloading one ton of goods.

	Performance in man hours/t *from*	*to*	*Capital investment.*
variant 1:	0.72 mh/t	0.1-0.15 mh/t	5.3-11.5 roubles/t
variant 2:	0.72 mh/t	0.2 mh/t	3.9- 9.7 roubles/t
variant 3:	0.72 mh/t	0.3 mh/t	

The capital investment in forklift trucks etc. varies at the Soviet Union Railways as indicated in the above data. The data actually obtained in practical operation diverge a little from the experimental. They mention at that, that transport-cost from the warehouse of consigner to that of consignee and consequently the extra transport-cost caused by palletization varies according to the distance involved and the palletization variant adopted.

In reporter's opinion this is the reason on the score of which the Soviet Union Railways reached the conclusion that up to 200 - 300 km the first variant is the most effective method, upwards of this distance the second variant.

The *Swedish State Railways* estimate their saving in staff due to the introduction of the pallet system in the shed at approximately 275 men and the extra cost for the forklift trucks, hand lift trucks and pallets equal to the cost of approx. 100 men. The profit accruing from the rationalization is estimated at the cost of 175 men, there moreover may be good possibilities of further improvement of the organization which might lead to further savings.

No mention of pre-calculations is made by this Administration, one of the first Railway Administrations in Europe to begin with palletization (1940), while in the estimation of the practical results only part of the cost-factors are taken into account.

The *Netherlands Railways* reply that thorough analyses as regards the effect upon the total cost of the parcels transport, were made by their subsidiary company Van Gend & Loos both before and after the introduction. This effect appeared to be not entirely favourable as was already shown by pre-calculations, made on the score of particulars obtained by experiments.

In the sheds where the experiments were made, the cost per unit of parcels did prove to decrease to such an extent that it more than compensated the extra cost mentioned in question 22. At the same time, however, an improved working method without mechanization was introduced in other depots, which method entailed a, be it smaller, improvement of performance hence decrease of cost, without the counteracting increased cost of equipment, installations or transportation by rail.

Other considerations which will be mentioned in the second part of this paragraph (2-b) have led to it that nevertheless throughout palletization has been adopted as the system.

As regards the results obtained with the throughout introduction of palletization by Van Gend & Loos, the Netherlands Railways report that performance has not increased so much that the saving of personnel - cost counterbalances the total cost of forklift trucks, hand fork trucks, pallets, boxpallets and the additional cost of more solid shed floors, space for riding tracks, the heavier demands put to the floors of wagons and delivery vehicles and the additional weight to be carried.

The improved working methods now introduced are expected to produce better results. At judging the present result, it should be taken into consideration that the number of consigners that present the parcels palletized is as yet small. Recently the number of clients with whom a pallet-pool agreement has been concluded gradually increases on account of a systematic campaign. Another remaining problem is that only in a very few cases palletized delivery to consignee is possible. This is partly due to the character and composition of the parcels traffic at the Netherlands Railways, to the lack of suitable equipment for unloading the pallets from the delivery vehicles — for, as previously mentioned, the Netherlands Railways/Van Gend & Loos perform the delivery themselves! — with other means than forklift trucks, which consignee as a rule does not possess.

In their calculations Van Gend & Loos have tried to eliminate all attendant factors of influence. At the analysis of the practical results, especially the labour-performance, this proved to be very difficult, the more so as the introduction was spread out over a number of years.

For instance, during the introduction on a large scale after 1953 a rapid increase of the turnover coincided with an increasing tightening of the labour market, both due to the general economic development.

On account of this a strongly increased labour-turnover arose, which undoubtedly affected labour-performance. The labour-turnover was considerable, especially of forktruck-riders, who on account of the introduction of forklift trucks in all kinds of business undertakings, — among which own clients — were in heavy demand, and made out of Van Gend & Loos a training-school for forktruck riders.

On the score of these considerations Van Gend & Loos estimated the effective saving of personnel at approx. 300 men, which is to be compared with the cost of 110 forklift trucks which equal that of 220 men. For the sake of completeness it is added that the forklift trucks are in operation 16 hours a day.

The influence upon the degree of loading of the wagons is also difficult to determine exactly. On account of the rise in turnover the average loading of the wagons increased in spite of the fact that now the extra weight and the volume of the pallets both make up approx. 25 % of the weight and volume of the parcels.

This was possible because, as the *Swedish*

State Railways also remark, a great part of the wagons was not fully loaded, undoubtedly a consequence of « the classical system » of dispatch and the resembling Swedish system.

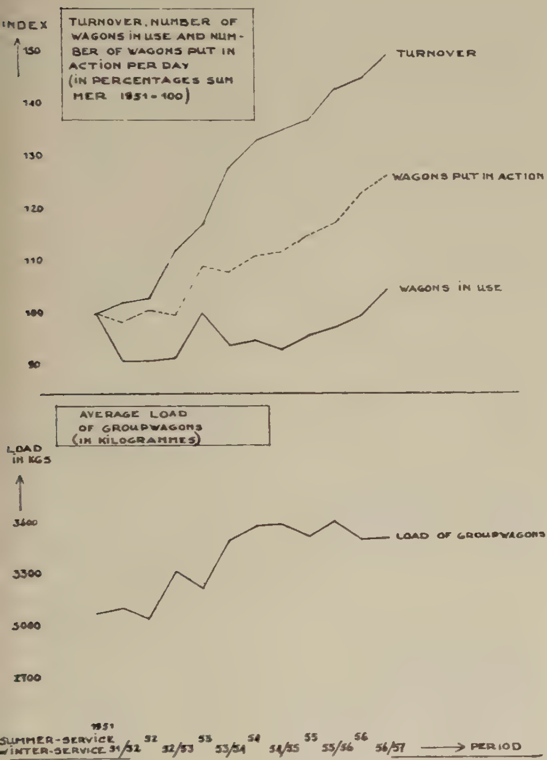

Fig. 19.
Netherlands Railways.

Therefore an estimate was made of the number of additional wagons which the Netherlands Railways had to put in operation on account of general palletization. This estimate amounted to approx. 10 %. By the greater speed of circulation — quicker loading and unloading — part of this number is certainly gained back. How much the number of wagons in use has actually increased on account of palletization cannot be ascertained by the Netherlands Railways, because also on account of other factors — a.o. faster trains, — the circulation speed has increased at the same time.

A graph supplied by the Netherlands Railways presenting a picture of the development of the turnover (in tons per operational day), the number of wagons and the average loading follows opposite (fig. 19).

Taking together the replies it may therefore be said that the complexity of many factors apparently render an accurate calculation of the direct economic results of palletization extremely difficult. Perhaps this is the reason why several Administrations have not made a calculation of the saving. Of the Administrations who did make one the *Soviet Union Railways* and the *Swedish State Railways* mention favourable results, without indicating what these amount to after deduction of all unfavourable factors, whereas the *Netherlands Railways* come to a deficit.

b) **Other factors.**

It goes without saying that in view of the above, apart from the economic ones a number of other factors have played a decisive part. The completest explanation of these is supplied by the Swedish State Railways and the Netherlands Railways.

The *Swedish State Railways* mention the following considerations :

Developments on the transport market show that unit loads are becoming increasingly common. A unit load proceeding untouched in the transport chain from producer to consumer from the point of view of national economy naturally is the most rational transport. All various links in this chain of transport ought to adapt their organization in order to be able to further the unit load without a hitch, be it on pallet or in container. This also goes for the railway. *Railway users want to tender palletized goods for transport to the railway and also want to receive certain goods palletized from the railway.* Even if this is practised on a rather mo-

dest scale in Sweden, one should take into account the probability that demands for such an exchange will increase. The railway is therefore, willy-nilly, forced by external conditions to handle goods on pallets.

Other advantages mentioned by this Administration are, that a proper pallet organization expedites the flow of goods and therewith, to a certain extent, the circulation of goods wagons, and creates the conditions for mechanized and less fatiguing shed work. In this way the possibilities for the railway of competing with other transport companies increase.

As for the disadvantages, the return journeys of empty pallets decrease the more palletization increases. The slight increase of the number of wagons put in action is outweighed by the quicker circulation of the wagons.

The above considerations are almost identical with the motives and practical results of the *Netherlands Railways'* subsidiary company Van Gend & Loos. In the Netherlands the railways are the only transport undertaking which carries parcels traffic palletized on a large scale and throughout the country.

The Netherlands Railways — as for that matter is also done by the Swedish State Railways — conclude agreements with clients concerning the exchange of pallets.

That in spite of the not entirely favourable economic results, palletization of the entire smalls traffic has been decided upon, is mainly on account of the expectations as regards the wishes of the consigner. In addition to this the fact that, even without taking into consideration the situation in the labour market, without expediting the flow of goods in the long run, it would have been impossible to handle the increasing turnover within the existing depot accommodation without considerably delaying transport, carried weight in this decision.

Furthermore the social development tends to an increasing transition from heavy manual labour to mechanical labour. Finally the labour market had to be taken into account, which tightened to such an extent that man-power available in the normal way did not suffice, so that considerably more had to be paid for personnel drawn from elsewhere and for auxiliary hands from employment agencies.

Against the background of these motivations of palletization reporter would observe that palletization is an important means of competition for the railways in the struggle against road transport especially with parcels traffic.

Whereas general palletization at the railways entails only relatively little extra cost, at road transport the extra cost is very much higher. This is due to a difference in the structure of cost. With the railways the invariable element of cost is much greater so that the transport of a considerable higher weight or volume entails only a relatively small increase in cost. With road transport, however, the variable element of cost predominates, which is shown by the relatively high degree of loading of the vehicles. Though an increase of the weight or volume carried with road transport primarily leads to an increase of the capacity of the truck or the unit, this possibility is soon exhausted so that refuge has to be taken to an increase of the number of journeys.

Whereas an increase of the capacity leads to less than proportional higher cost, an increase of the number of journeys, especially at great distances, leads to almost proportional higher cost.

Moreover the ratio between volume and carrying capacity of road vehicles is restricted by narrow limits. Road transport has in general aimed at acquiring just those kinds of traffic that enables both to be utilized to the full.

In most cases this aim has been reached with the consequence that road transport attracted the goods which as regards volume/weight were most favourable and left the bulky goods for the railways. Now palletization, requested by consigners, has disturbed this ratio, palletized unit loads

in comparison with the net weight of the parcels being much bulkier than unpalletized parcels.

3. Suitability of the packages.

23. — *What proportion of the traffic can reasonably be palletized, taking into account :*
- *the use of pallet-crates on the one hand for packages of irregular shape;*
- *progress expected in packaging on the other hand.*

Have any effective steps been taken as regards packaging characteristics (submultiples of the dimensions of the pallets for example).

a) Suitability of the traffic for palletization.

To this question the *Soviet Union Railways* reply, that the adoption of pallets is expedient for the transport of goods whether these are packed in rigid or in soft material. The use of boxpallets obviously justifies itself for goods to be transported without packing.

The *American Railroads* and *British Railways* are unable to estimate the proportion of traffic that can reasonably be palletized. At the *Norwegian State Railways* 50 - 60 % of the goods are conveyed on pallets, this percentage varies because of differences in distances in goods sheds, the nature of the goods and the possibilities of utilizing the capacity of the pallets.

The *Swedish State Railways* say that approx. 80 % of the goods can be transported on pallets, in boxpallets or containers. The percentage is highest at the *Netherlands Railways,* where 90 - 95 % of the packages are suitable for palletization. More than one third of these go into boxpallets, viz. those packages which on account of their dimensions or fragility cannot be loaded on pallets and remainders of large palletized consignments.

b) Standardization of packing.

The *Soviet Union Railways* expect a revision of the standards for various types of packing ascertaining those which meet best the requirements of palletization and exploit to the full the capacity of wagons and road vehicles. Work is in progress on the standardization of pallets.

The *British Railways* mention that little progress has been made. Many firms have standardized packages to suit pallets but only for domestic purposes or for traffic in full wagon loads.

At the *Norwegian State Railways* standardization of packing is still studied.

The *Swedish State Railways* have a permanent body « Standardization of Packing » in which a great number of industries and transport companies are represented. In every case where it is possible the standardization is based upon the dimensions of the standard-pallet used in Sweden.

The *Netherlands Railways* co-operate with industry to obtain more efficient packing. Not much has been done as yet as regards co-ordinating the measures of the packing with those of the pallets, though some firms have made important steps in this field. The lack of co-ordination between measurements of packages and of pallets is for a great deal compensated by the use on a large scale of boxpallets, thus rendering standardization less urgent than would be the case without the use of boxpallets.

Standardization of packing incidentally is a comprehensive problem for which on short terms no solution can be reached. The fact is that alteration of the measurements may imply that the whole shape of the product has to be altered, which entails great investments for industry.

B. Technical problems.

About the technical side of palletization on the whole few data have been received. Apparently these present no great difficulties except the pallets with which experiments are still being made almost everywhere.

1. Pallets.

24. — *Please give the dimensions and constructional specifications of your stock of pallets (attach a drawing). Are the dimensions you have chosen conditioned by those of your vehicles used for transporting the pallets (wagons and lorries)?*

What damage most frequently occurs to your pallets? What remedies have you under consideration?

Do you consider it better to make solid pallets which are dearer but require fewer repairs or on the contrary cheaper, more fragile pallets which have to be repaired or renewed more frequently? Why?

a) Types and dimensions.

As is usually the case with new implements there is a great variety of models and dimensions of the pallets applied by different countries. A survey of the data supplied follows below:

Administration	*Type*	*Dimensions (in mm)*		*Material used*	*Specifications*
British Railways	4-way	(32" × 40")	813 × 1 016	wood	—
		(32" × 48")	813 × 1 219		
		(40" × 48")	1 016 × 1 219		
		(40" × 60")	1 016 × 1 524		
	2- or	(36" × 40")	914 × 1 016		
	4-way	(40" × 40")	1 016 × 1 016		
Netherlands Railw.	single deck two way		1 000 × 1 200	wood	open or closed-upper deck, outer boards of upper deck and stringers or blocks of hardwood, other parts soft wood.
	winged id.		1 000 × 1 200	wood	
	single deck 4 way entry		1 000 × 1 200	wood	
Norwegian State Railways	single deck 4-way entry		800 × 1 200	wood	open upper deck (see drawing)
American Railroads	?	(3' × 4')	914 × 1 219	wood	—
Soviet Union Railw.	—		800 × 1 200	metal or wood	—
			850 × 950		
			850 × 1 200		
			1 000 × 1 200		
			1 200 × 1 600		
			900 × 1 200		type most frequently used.
South African Rls.	double deck two way entry		1 219 × 1 524 (4' × 5')	wood	stringer of hard wood open upperdeck
	winged, id.		1 168 × 1 524 (3'10" × 5')	hard wood	open upperdeck
	winged, id.		idem	steel	open upperdeck
Swedish State Railways	single deck 4 way entry		815 × 1 220	wood	open upperdeck (see drawing)

For further indication of the different types some sketches are to be found in appendix 8, 9, 10 and 11.

b) **Choice of the measurements.**

At deciding upon the measurements most Administrations have taken into account the dimensions of railway wagons and road vehicles.

The *American Railroads* on the contrary say that their measurements are best adapted to the use on platforms trailers and highway vehicles which undoubtedly coheres with the fact that in the United States pallets do not travel in the wagons.

The measurements are principally adapted to those of the wagons, because, as the *Swedish State Railways* observe, these are already standardized, those of the road vehicles not yet.

At the *Netherlands Railways* the measurements of the lorries and semi-trailers used for the transport of palletized loads, are primarily adapted to those of the pallets, as far as this is possible within the frame of legal regulations.

c) **Damages.**

Several Administrations mention frequent damaging of the outer deck boards, owing to impacts by forklift trucks. The *American Railroads* and the *South African Railways* advise to avoid this by applying strap steel on the outer edges to reinforce these boards.

The *Netherlands Railways* with the same object have taken the following measures :

— these boards are made of hard wood;

— the upperdeck boards are placed against each other, so that the impact against the first board is also met by the adjoining boards;

— a trial is being made at which the outer stringer under the first deckboard is fitted with a clamp enabling additional fastening of this deckboard (appendix 8 b).

— a trial is made to cover with rubber buffers those parts of the forks on the forklift truck that are brought into contact with the outer boards of the pallet.

The *Swedish State Railways* to reduce damage to the outer boards, are considering a ribbed reinforcement of the ends of these boards. Tests with reinforced pallets are being carried out. To decrease damage to the supports between the decks this Administration has adopted cylindrical supports, the wooden core of which is reinforced with sized « kraftpaper » instead of square supports. So far the new supports have turned out well. It will probably be necessary to standardize the manufacture of pallets in order to realize a European palletpool.

The *Norwegian State Railways* mention nails sticking out as a special problem. This matter is being studied.

d) **Choice of material.**

At the choice of materials, which as shown is principally wood, naturally the wood resources of the countries have played a part, as these resources a.o. define the cost.

The opinion of the northern countries and the Soviet Union Railways, that wooden pallets are the best is therefore based on this aspect as well. At that, wood has the advantage that it is less apt to slide on the forks of a forklift truck and that wooden pallets *are cheaper than the metal types.*

The *Swedish State Railways* choose a cheap pallet, on the one side, on account of the long duration of circulation at door to door transport, on the other side, to have the investments of the participants to the pallet pool remain small.

The *South African Railways* and the *Netherlands Railways* prefer sturdy pallets as maintenance cost is lower.

2. Boxpallets.

25. — *Please give the dimensions and constructional specifications of your stock of pallet-crates. (Attach a drawing).*

If there are several types, please specify their respective usages.

If needs be explain the methods used to stack them.

What damage most frequently occurs to your pallet-crates?

The use of boxpallets is very limited. The *Swedish State Railways* are making tests with collapsible pallet crates. So do the *Norwegian State Railways*. The *Soviet Union Railways* are developing pallets with enclosures of wire-mesh.

The *Netherlands Railways* use boxpallets on a rather large scale. As of the pallets the base is 1 000 × 1 200 mm; the loading height is 770 mm. The outside measurements are 1 000 × 1 200 × 940 mm. The boxpallets are made of profile steel, the loading surface is made of deal (fig. 20).

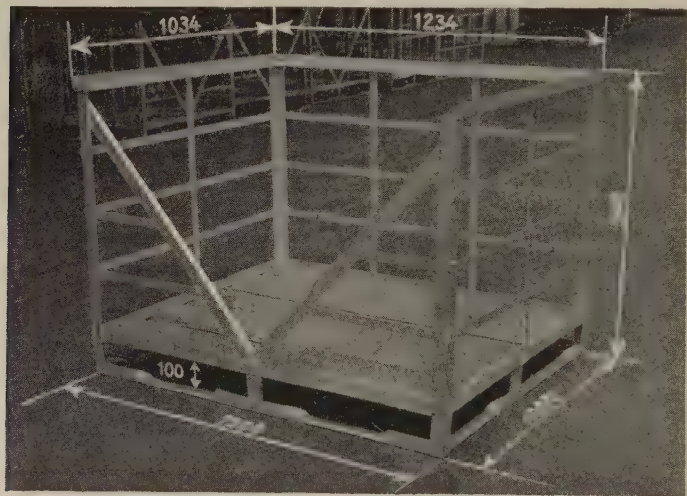

Fig. 20.
Van Gend & Loos. Boxpallet.

Have you experienced any difficulties as regards maintenance or repair?

Do you use or have you tried pallet-crates with folding sides?

Please give your opinion on the usefulness of such types (taking into account the time taken to fold up or unfold the sides and the higher maintenance costs) or the reason why you have given up using them.

The places where the forks are stuck into the boxpallet are most liable to damaging. As with the pallets favourable results are expected of the use or rubber buffers on the forklift trucks. This Administration has no experience with collapsible pallet crates.

3. Installations.

26. — *What alterations have you made to the installations in the goods*

depots in order to make palletization possible? Please make it clear if such alterations concern :

- *the strength of the platform surfaces;*
- *the height of the platforms;*
- *the position of obstacles (doors, pillars, etc.).*

Please state in addition if in view of general palletization certain layouts of the depots should be retained in preference to others.

The alterations to existing depots have on the whole been slight. Principally they consisted of strengthening the floors.

At the *Netherlands Railways* this was done by replacing the old floors by new ones of steel-edged slabs of reinforced concrete or asphalt-concrete. Moreover, at some narrow depots the outside platform border has been broadened. For new depots preference is given to a roof supported by pillars in the walls only. Except that in the depot there must be sufficient space for tracks for the forklift truck and for storage of pallets and box-pallets, palletization has not influenced the layout of new sheds.

At the *Swedish State Railways* in some cases platforms were broadened also to permit conveyance by forklift truck. Neither in Sweden nor in the Netherlands has the palletsystem required an adaption of the platform height. In Sweden experience has taught that the organization of the pallet system can be adapted to depots of entirely different sizes and designs. It is therefore probably only necessary that a few general requirements of the premises are met, viz. :

- sufficient carrying capacity of the floor;
- sufficiently wide tracks;
- relatively short conveyance distances.

The *Soviet Union Railways* give an analogous opinion. To strengthen the floor they principally use asphalt-concrete covers, they moreover intend to raise the depot floor from 1.10 m to 1.20 m above track level. The drawback of thresholds has been solved by the use of small ramps.

At the *Norwegian State Railways* the standard ramp height to the railway track has been increased from 1.10 m to 1.18 m above rail head. Height of ramp or shed floor has been fixed at 1.10 m above ground-level. Widths of ramps to railway tracks and widths of doors have partially been increased. Finally scales have been equipped with larger weighing platforms. No substantial alterations have been made as regards goods sheds.

4. Wagons and road vehicles.

27. — *What effect does palletization have upon the characteristics of the wagons and road vehicles (strength of the floors, suspension, dimensions of the doors, etc.)?*

Have you made any alterations to the stock in service? What are they?

a) Wagons.

The *Soviet Union Railways* mention that no special alterations are required in bodies of the wagons, but that widening of the door embrasures might be desirable. From the point of view of preservation of the rolling stock, trucks with a capacity of 0.75 - 1 ton are thought to be best. The use of pallets in conjunction with trucks of a load capacity of up to 1.5 tons does not cause any damage to floors or other parts of the wagons at this Administration, this contrary to the *Netherlands Railways* where the floors suffer quite considerably from the wheels of the forklift trucks. Consequently in the Netherlands parcels traffic wagons are used with a sturdier floor of hard wood and a doorway of 2 m conformable the U. I. C.-standards.

As regards these standards, the *Swedish State Railways* observe that from the user's point of view a wider door is always preferred. These wagons should be able to

sustain a wheel-pressure of 1.2 tons to be suitable for forklift trucks. From the reply cannot be gathered, however, that the U. I. C. standard wagon is introduced in Sweden.

The *British Railways* report that experience with full wagonload of palletized traffic indicates that doorways up to 8′ 6″ (= 2.59 m) wide are necessary. Wagon floors are sufficiently strong to carry powered pallet trucks, but if forklift trucks are used the wagon floors require strengthening.

The *Norwegian State Railways* say that no alterations to the rolling stock have been made.

b) **Road vehicles.**

Of this subject only the *Netherlands Railways* say something. Their subsidiary company Van Gend & Loos have in service a number of motor vehicles specially built for the transport of palletized loads. These vehicles have reinforced wooden floors. The floor measurements are adapted to the measurements of the pallets viz. inside measurements 5.00 × 2.24 m so that 8 pallets can be loaded unstacked or 16 stacked. To be able to unload and load at clients who have no platform the wagons are fitted with laths on both sides instead of a closed cover. Experience with these vehicles proves to be favourable. A remaining difficulty is, however, that the pallets cannot be unloaded as units at the many clients who neither have a platform nor a forklift truck. For this trials are now made with cranes, fixed to the pallet-vehicle. Up to now loading and unloading with these takes too much time (fig. 21).

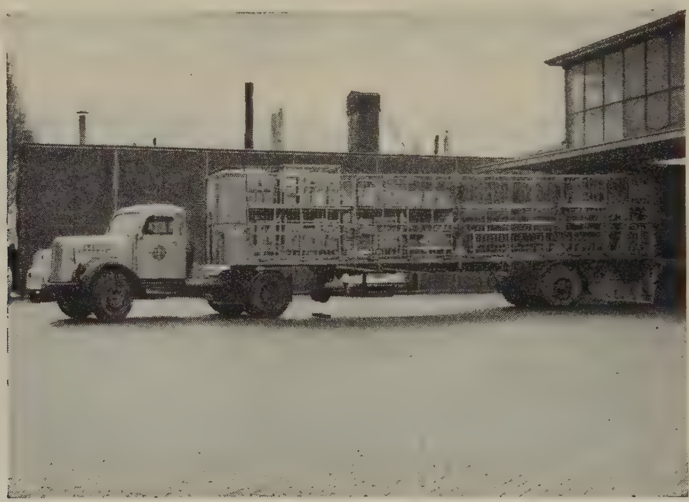

Fig. 21.

Van Gend & Loos. DAF semi-trailer HD 1 800 - 1 300 9 t for transport of palletized loads. Three of these are in use between Rotterdam depot (« group head station ») and Schiedam depot (secondary station) as a « dumpwagon by road » (I - 3 a). The tractor is a Scania Vabis L 51 34, 4 - cyl. diesel.

C. Operating and handling problems.

1. Use of the wagons.

28. — *Has palletization had any effect on the average load of the wagons and consequently upon the number of wagons used for the parcels traffic?*

Has any improvement been noted owing to the greater concentration obtained thanks to introducing supplementary transhipment operations?

On the other hand has palletization led to a better or poorer use of the available volume of the wagons (stowing).

Little seems to be known of the effect of palletization upon the use of wagons. Apparently this effect has not been studied and included in the considerations concerning the introduction of the pallet-system by the various Administrations, at any rate not for parcels traffic. The replies to the above questions are namely very brief and not very concrete.

The *British Railways* have no experience on this point. The *Norwegian State Railways* estimate that palletization has led to a less intensive use of the available volume of the wagon.

At the *Swedish State Railways,* palletization has not been introduced on such a scale that any increase in the number of wagons is noticeable (cf. page 313/83 : annual tonnage 1 246 000, stock of pallets 78 000). At a big rail-and-road transport concern in Sweden, to which the Swedish State Railways passed on question 28, and the closed railway wagons of which are known to be well exploited, railway users infrequently offer for transport unit loads on pallets. This concern remarked that if all goods that can be palletized were so treated, this would probably result in a decrease of the average load of the wagons and would lead to a less intensive exploitation of the wagon volume. The concern can depart from the principle that ordered railway wagons should be exploited for the full 100 %, if only the cost of a reduced average load in the wagon is compensated by a reduction of the handling cost. For a forwarding company, as is apparently meant here, this is an understandable point of view.

More hold is offered by the *Soviet Union Railways'* reply when they write that in determining the effectiveness of palletization the following points should be taken into account :

1) an increase of approx. 90 kg in the weight of tare per ton of goods shipped by road- and railway-transport;
2) a decrease of 10 - 15 % in the effective use of the weight-capacity of the wagons on account of their carrying pallets;
3) an increase of approx. 5 % in transhipment work on account of transhipment of pallets from loading to unloading points;
4) the necessity of supplementing capital outlay for the procuring of pallets;
5) the necessity of special accounting and arrangements for a pallet park.

The *Netherlands Railways* say that by transporting loads palletized the average loads of the wagons has been lowered by approx. 10 %. At a considerably higher turnover than the present, this percentage will rise because then transport between many « groups » without the use of pallets will already demand a full or almost full wagon. The estimated maximum influence will be 20 to 25 %. The organization of parcels traffic in Holland has not been changed in that respect that the number of groups has been reduced, which would be the consequence of cheaper and quicker transhipment and by which the number of partially loaded wagons, especially to small « groups », would decrease. Some such system is being investigated, together with the possibility to combine some small « groups ».

For the time being the accelerated loading and transhipment has only been made

use of at the despatch depot for accepting goods tendered at a later hour. The use of the available volume had decreased. Before the introduction of the pallet system the packages were stowed up to the roof in fully loaded wagons. This is not possible with pallets. The quality of stowing can still be improved.

2. The work in the sheds.

a) Alterations in the organization.

29. — *Has palletization had any influence upon the organization of the work in the sheds? If so, what?*

In particular have you profited by the equipment with pallets and the corresponding machines to standardize completely handling operations and to put packages which are not palletized on pallets on arrival or departure?

The *British Railways* have no experience; at the *Norwegian State Railways* palletization has led to a decrease in number of staff on each team and to a change in the organization of the work.

The *Soviet Union Railways* stress the social consequences by observing that the basic effect of palletization is that it has made possible complex mechanical loading and unloading operations thus releasing an appreciable number of men who formerly worked by hand or with wheelbarrows. Furthermore palletization makes better use of covered sheds in goods depots and allows stacking and storing of goods to a height of 2 to 3 loaded pallets.

An identical observation about the social consequences is made by the *Netherlands Railways,* where internal conveyance with wheeled stillages and wheel barrows, so with manpower, has been replaced by mechanical conveyance, and for stacking the goods in the wagons manpower has been replaced by mechanical power. Stowing has been shifted from the wagons to the acceptance-points where the goods are palletized as much as possible. Consequently stowing is now done in much smaller units. The consequence of this was, that the responsibility for the proper quality of the stowing has been transferred from the so-called stower to the forktruck rider. It is he who judges if the palletized unit loads are stacked in such a way that no damage can arise.

It is not possible to hold the « palletizer » responsible as palletizing is done by too many people, also by consigners who tender the goods at the depot. Working-methods differ in detail, however, according to the circumstances at the different depots.

The *Swedish State Railways* reply that on account of palletization transport work is simplified and economized by the transportation of the goods in well disposed units, also in the many cases that the goods are stowed in the wagons without pallets. In those depots in which palletization is the general method, all goods are palletized either by the consigner or by the railway at reception.

b) The process in the depots.

30. — *How have you organized palletization at the stations?*

a. *As regards methods (methods of grouping the packages for example):*
   - *pallets or pallet-crates for a single destination;*
   - *pallets or pallet-crates for several destinations from the same station;*
   - *pallets or pallet-crates for several stations to be sorted out at a transhipment centre.*

How are these different categories of pallets recognized during transport (for example by special additional labels).

Is it possible to run regular pallet services from certain stations?

Obviously on account of a not quite clear translation (French text : « palletisation par le soin des gares » and « destinataire » instead of « destination ») this question has been answered by the *Soviet Union Railways* with the observation that palletization has not been generally intro- « group » when these are made ready for despatch and to tender these at the depots or offer to the collection service already pre-sorted. The collection service has similar orders. On arrival at the depot the goods already weighed by consigner or agent are directly palletized on dif-

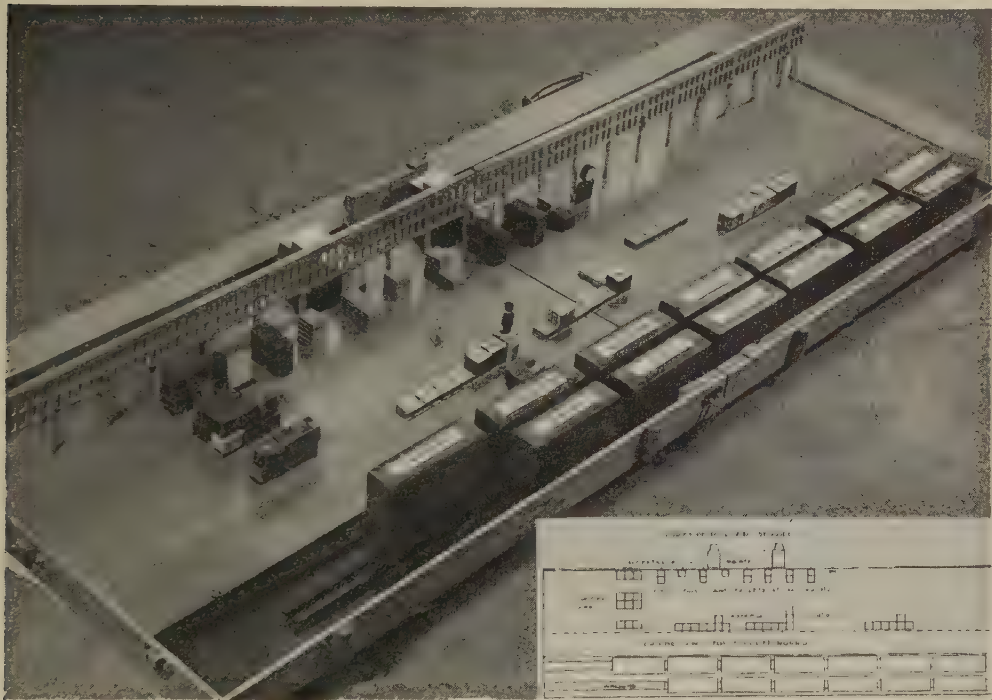

Fig. 22.

Van Gend & Loos. Instruction model of a part of a modern shed at forwarding. Flat pallets on assembly points have not been packed as small model packages are not on hand. Comp. fig. 23 (III - A - 1 e and V - C - 2 b).

duced on the stations of the Soviet Union, whereas judged from the above (viz. page 311/81, 3rd variant) this is the case in the depots.

The *Netherlands Railways* endeavour to have the sorting of the packages take place per group of destination, i.e. per wagon, as early as possible. Consigners have been requested to sort the goods per

ferent pallets for the various destinations.

At the receiving doors a number of pallets and/or boxpallets are available which are placed near the vehicle and get the necessary destination (fig. 22).

The packages still to be weighed or measured are palletized at the scales. Pallets which are not fully loaded with packages from one vehicle remain there and

are supplemented with the packages from the next vehicles. Approx. 75 % of the palletizable packages are handled in this way.

Small lots suitable for pallets are conveyed on pallets or stillages from the receiving doors to the sorting-platform and are sorted there in boxpallets per destination « group » (see also Chapter III) (fig. 23).

When unloading at the destination « group » depot complete pallets for one delivery district are directly conveyed to the corresponding bay. Pallets with loads for several delivery districts are unloaded and sorted over the corresponding bays. It appears from tests at random that approx. 45 % of the pallets and 30 % of the boxpallets have a load for one district, often even for one consignee.

During transport and in the depot the destination of the pallets can only be ascertained from the labels on the packages.

Only on the sorting-platform the destinations are indicated also by sign-boards over the boxpallets.

As regards this question, the *Swedish State Railways* supply the following particulars.

At the weighing machines pallets are ranged in numbers corresponding with the goods wagons for which goods are received at the door in question. Consequently one pallet for each wagon.

Fig. 23.
Van Gend & Loos. Assembly points in a fully palletized shed. Comp. fig. 22.

The pallets for which most goods arrive are placed as near to the door as possible. The transport indication is given on a fixed or detachable sign. The order in which the pallets are ranged has been indicated on the shed floor by painted squares and signs corresponding with each wagon. On the pallets arranged in this way all packages, suitable for palletizing are sorted out.

Bigger consignments are loaded on special pallets which are taken from the storage-place for empty pallets near the

weighing-machines. If the wagons are ready for loading, the pallets which have been sufficiently loaded are conveyed directly to the wagons. If this is not possible, the pallets are placed in special bays for temporary storage with appropriate signs. Whenever the number of destinations become too great, the Swedish State Railways as a rule have a number of pallets at the two adjacent receiving doors, arranged in two rows with in between a riding track. The functions allotted to these pallets are indicated by fixed signs suspended from the roof. However, special pallets are provided at every door for those wagons receiving the greatest amount of goods. In cases in which there is no direct wagon for a certain destination, the goods for several stations are loaded together on a pallet, which is despatched to a transhipment station on the transport route of the goods. Here the goods are re-sorted and loaded on other pallets to be despatched either directly to destination or to another transhipment station.

Apart from the labels on the goods there are no identification marks on the pallets. At the beginning of the operations in the incoming shed the required number of pallets is conveyed to the wagons. As far as possible the goods are loaded from the wagons on these pallets, which are provided with permanent numbers. Every time a loaded pallet is conveyed to the shed, an empty pallet is taken on the return journey. When the goods are being checked, both the number of the pallet and the number of the bay to which the pallet is conveyed are noted on the consignment note. The pallets are placed according to a certain system in a certain part of each bay. The pallets loaded with consignments consisting of larger numbers of packages are placed where they are easily accessible. For an easy recovery of the pallets for delivery in each bay there is a special notice-board with a schematic plan of the bay with the position of the pallets indicated with painted rectangles. On this board the numbers of the pallets actually in the bay are noted. The delivery staff are responsible for keeping the board up to the minute. Towards closing time the remaining packages are stacked on shelves which are to be found in each bay. The shelf-sections are numbered from 0 to 9 and the packages are placed on the shelf-section of which the number corresponds with the last figure of the pallet number. Trials are made with pallet-shelves.

c) Use of equipment.

b. *As regards stock :*

— *To what extent do you use the different types of material (pallets, pallet-crates, tackle such as hoists, etc.) ?*

It has already been dealt with in this and preceding chapters to what extent the different types of equipment are used.

In what proportion boxpallets and pallets are used is told by the *Netherlands Railways* who report that they use two flat pallets against one boxpallet. The boxpallets, however, contain on an average 20 packages, whereas the (flat) pallets carry an average number of about 8 packages. The heaviest and biggest packages are loaded on pallets, the others in boxpallets. At other Administrations flat pallets are used almost exclusively.

3. Internal problems.

31. — *What technical difficulties have you come up against in the transport and handling of pallets or pallet-crates :*

— *packages sliding about on the pallets or unstable loads ?*
— *fitting them in the wagons at the end of loading operations ?*
— *pallet loads found to be upset when unloading ?*
— *etc.*

What remedies do you suggest? In particular indicate, giving the results obtained, if you make use of certain methods such as banding, gluing, use of adhesive strips, etc. to avoid having to carry tackle.

32. — *What inconveniences result from the coexistence of palletized and non-palletized goods:*
  - *in the depot (different machines and handling circuits, for example)?*
  - *in the wagons (loss of space, damage, etc.)?*

a) Palletized goods.

The *Netherlands Railways* mention the following difficulties:

- the packages on flat pallets shift, because interlocking loading (in brickwork fashion) is not always possible on account of the measurements of the packages and often too slippery packing;
- packages are loaded outside the profile of the pallet;
- pallets with heavy loads are often placed on pallets with not so sturdy loads;
- pallets are not always properly placed together so that the load can shift.

The consequence of the above often was, that when unloading, the packages had to be reloaded or straightened before the pallet could be conveyed. Even worse was the damage met with.

It appears that shifting of the load mostly commences at the top layer of packages. For this reason trials are made with the use of elastic bands, which are drawn around the top layer.

Besides there is a close co-operation with the Dutch Institute for Practical Application of Scientific Research to acquire a kind of packing which is less slippery. This packing, however, is not very popular with the manufacturers.

Boxpallets are also made use of on a large scale to give the load in the wagons the necessary firmness, to take the packages which do not fit on a pallet, and to palletize smaller consignments or packages. It is not permitted to load packages on the pallet to a height of more than one metre.

The Netherlands Railways write that also with the use of boxpallets mistakes are being made, such as:

- loading too heavy packages in the boxpallets, so that their unloading out of of the boxpallets requires too much energy;
- improper utilization of the room in the boxpallets with as a result damage to the packages and underloading of the wagon;
- loading the boxpallet too high (above the supporting edge) causing damage when a (box)pallet is loaded on top or unloaded;
- stacking boxes on the loads of flat pallets was a cause of damage because the boxpallet rests on the steel edges.

Damage furthermore was caused by both boxpallets and pallets with liquid loads — paint, acids, etc. — being placed on top of other boxpallets. Damage to these packages consequently curtails damage to the packages below.

A decrease of these difficulties has been realized by:

- a systematic training of the staff;
- furthering routine by allotting fixed tasks;
- separating the supervision on palletizing from the supervision on the loading of the wagons;
- rules for systematic stowing of the load in the wagon.

This last point implicates a.o. reserving a corner of the wagon for goods not fit to be palletized and the use of boxpallets for securing the load (fig. 11).

The *Swedish State Railways* use trusses to facilitate the loading of parcels with a tendency to slide. Railway users secure the pallet loads with supports, bands, glue-

ing, etc. To encourage the securing of pallet loads the Swedish State Railways allow freight-free return of extra auxiliaries for this purpose.

The *Soviet Union Railways* suggest the use of boxpallets as a remedy for the kinds of goods which cannot be stacked on pallets because of their lack of stability. The use of boxpallets obviates the necessity of strengthening goods on pallets. A method for increasing the stability of packages on pallets is the choice of the proper way of loading in a « binding-brickwork » etc., and also in limiting the height to which the packages are stacked.

b) Non-palletized goods.

The coexistence of palletized and non-palletized goods does not present any special difficulties in the depots, except perhaps an increase in the need of space.

For the conveyance of non-palletized goods the *Swedish State Railways* and the *Netherlands Railways* use forklift trucks and wheelbarrows.

The situation becomes less favourable when the goods cannot be palletized for want of pallets, the *Norwegian State Railways* remark. In that case it is very difficult to perform the work with the staff available.

According to the *Netherlands Railways* and the *Soviet Union Railways* the presence of goods unsuited for palletizing is an inconvenience; according to the *Swedish State Railways* it is not.

The Swedish Railways remark that a certain rearrangement of the goods is always necessary, either with or without a pallet system. Decisive for the amount of damage are the skill and judgement of the loading staff.

In the Netherlands where, contrary to Sweden, the pallets are stacked, the presence of goods, unsuited for palletizing is an inconvenience, because it is the very stacking which is hampered by it, thus causing both loss of space and damage.

Formely many of these packages could be placed on others of regular shapes, with the boxpallets this is no longer possible. To avoid damage, a corner of the wagon is kept free for these packages, so that they cannot become squeezed between (box) pallets (fig. 11). No remedy has been found against the loss of space.

c) Empty pallets.

33. — *How much empty pallets and pallet-crates traffic have you?*

How are the empties distributed?: according to a definite programme made out once for all, or periodically (daily or weekly) according to the orders given by a special organization according to the position at the stations?

Are empty pallets carried in the wagons used for the parcels traffic or by other means?

At the *Netherlands Railways* 1 200 boxpallets and 2 000 pallets are daily despatched empty from depots with a surplus at incoming to depots with a shortage of pallets at outgoing. This is done according to a fixed plan. For this plan 29 « group-wagons » are used, part of which otherwise would have to be sent on empty. The remainder travel in smaller parties by the usual « group-wagons ».

All depots daily report the total number of boxpallets and pallets received and those in stock to a central body which, if necessary, corrects the circulation of pallets. The overall number of pallets loaded daily is approx. 16 000, the number of boxpallets approx. 7 500.

Since 1952 the *Swedish State Railways* have not counted the circulating empty pallets in the parcels wagons. Then this number according to random-tests was 1.1 per wagon. The distribution system in Sweden operates as follows: nineteen stations in different parts of the country serve as depot-stations for pallets. Every Thursday these stations have to supply

the Traffic Bureau with a report on the stock of pallets specifying the stock of loaded and empty pallets of the Administration, the number of pallets expected to arrive during the subsequent six days and the requirements for this period. Unforeseen greater requirements are stated in a special report.

d) The staff.

34. — *What have been the reactions of your staff to palletization?*

Does the staff appreciate the improvement in working conditions?

Does palletization involve special training of the staff? Have you organized any courses? If so, for what categories of staff? (markers off, drivers, etc.).

Is there any promotion in grade for certain specialized staff (such as the drivers of forklift trucks)?

With palletization the consequences for and the reactions of the staff are of considerable importance. This subject already has casually been mentioned on the preceding pages. In general these prove to be not unfavourable.

At the *Soviet Union Railways* and the *British Railways* the reactions of the staff are wholly favourable.

At the *Norwegian State Railways* the staff is interested in the use of pallets although some resistance against a systematic introduction of palletization may arise. The *Swedish State Railways* and the *Netherlands Railways* are still more reserved in their replies to this question.

The *Swedish State Railways* mention that the strength of the reaction depends on the time at which the reorganization is carried out, the way in which it is carried out and what technical facilities are placed at the men's disposal.

If the pallet organization in the depots is introduced when the traffic tide is low, thus giving the staff a chance to become accustomed to the new working-methods, palletization is as a rule generally accepted.

One condition for this is, however, that a sufficient number of forklift trucks and hand fork trucks are made available.

At the *Netherlands Railways* palletization has encountered little resistance. It should be kept in mind, however, that the gradual introduction chiefly took place in a time when there was a growing lack of personnel. With the working-conditions it should also be considered that these have improved for most, but are still rather unfavourable for the forklift truck-rider. In particular the vibrations of the truck are an inconvenience, whereas with cold weather the rider suffers for want of exercise on the open truck. Proper clothing can offer a reatively good protection against the latter.

The above-mentioned Administrations all give the forklift truck-riders a special course or training in the handling of palletized goods with forklift trucks. The *Norwegian State Railways* have also organized courses for goods shed managing, the *British Railways* have trained the supervisors.

The subsidiary company of the *Netherlands Railways,* Van Gend & Loos, has been organizing instructive conferences and discussions with local chiefs, managers, shed supervisors and palletizers.

At the *Swedish State Railways* the reorganization is carried out by specially trained officials who assist the local officials in instructing the staff and supervising the work. The latter remain responsible for the following-up of the new methods.

At the *Swedish State Railways* the following categories of shed staff are promoted to special functions:
— weigh-master in outgoing shed;
— stower in outgoing and transhipment shed;
— delivery-hand in incoming shed;
— loading-hand in incoming and transhipment shed.

At the *British Railways* operators of power-driven pallet trucks are given higher duty pay, operators of forklift trucks are paid the same as mobile crane drivers. At the *Norwegian State Railways* there has been no promotion for specialized staff. At the *Netherlands Railways* the fork truck-rider receives the same pay as a delivery van-driver without special certificate.

4. International Transport.

35. — *What repercussions might general palletization have on international transports?*
- *use of pallet-crates for taking goods across the frontiers under customs' seals?*
- *agreements made regarding the exchange of pallets or the creation of pools between the Administrations?*
- *etc.*

A more general use of pallets and boxpallets will of course have repercussions on international transports.

For bonded traffic small containers are used at present. In this case customs inspection is facilitated, as a container is easier to open and close than ordinary packing. None of the Administrations at the moment seems to dispose of boxpallets or pallet-crates which can be sent under customs' seals.

According to the *Swedish State Railways* these boxpallets should be cheap enough to be used for storing the goods. It will be rather difficult to comply with this condition.

Special regulations for the exchange of pallets among the Administrations are being considered by the R.I.V. Association. The U. I. C. are at present investigating the possibility of forming a European pallet-pool. The differences in qualities and dimensions of the pallets as yet present great difficulties.

The *Swedish State Railways* are of an opinion that an agreement on standardized rules for the manufacture and testing of the pallets to be used in the pool is a necessary condition. In this connection difficulties will arise due to, for instance, the different natural resources of the various countries with respect to the material used, different views as to how strong the pallet should be made, etc. This Administration observes that the international use of pallets may necessitate the construction of special types of railway-wagons, e.g. wagons with sliding walls. Proto-types of such wagons are already in use at the Deutsche Bundesbahn. International palletization is expected to lead to a reduction of handling and packing cost and reduced damage to goods.

The *British Railways* expect no insuperable difficulties!

The *Norwegian State Railways* mention that agreements on transport of pallets have been concluded with Denmark and Sweden.

Provisions for these transports have been included in the Scandinavian goods tariffs as follows:
- the gross weight of the consignment is reduced with the weight of the pallets, sides included, with a maximum of 25 kg;
- freight for at least 200 kg must be paid for every loaded pallet;
- if the empty pallet is returned within 3 months no freight for the return journey is due.

The matter of creating a Scandinavian pallet-crates pool has been discussed but has been postponed sine die.

D. Problems concerning palletization by clients.

At the beginning of this chapter it was observed that palletization is most profitable if it starts at the client's. At that it was said that palletization can be an important weapon in the competition with road transport, because the railways can offer external transport on pallets linking

up with the client's internal palletized transport, whereas this cannot (or only with great difficulties) be performed by road transport. Let us now see to what extent this linking of internal to external transport is wished by the client and on what conditions it is being brought into practice.

1. The interest of the client.

36. — *To what extent are your clients interested in the palletization of railway traffic?*
For what reasons:

a. *Do clients whose internal handling was not palletized look for:*

- *a reduction in the packaging required?*
- *a reduction in the handling required in consigning goods by rail?*

Do they limit palletization to such consignments or have they profited by this to extend it to their factories or stores?

b. *Do clients whose internal handling was already palletized look for:*

- *the extension of their internal palletization to outside traffic?*
- *have they agreed to modify certain features of their own palletization in order to adapt it to that of the railways?*
- *did they send palletized consignments before the start of palletization on the railway?*

Extremes meet: The *British Railways* state that there is no demand by traders for throughout palletization of parcels traffic. At the *Soviet Union Railways* a large majority of clients are convinced that transportation on pallets is expedient for the National Economy. In the Soviet Union the main criterion for judging any one mechanization method is the benefit reaped by the National Economy as a whole. Mechanization is carried out on a planned basis; palletization combines the interests of the railways and the clients in the best possible way in adopting a one-type method of mechanization. In the Soviet Union clients do not consider palletization a means of simplifying the work of packing but of reducing the number of transhipment operations.

Clients profit by the increased capacity of the sheds as a result of the increase in height of stacked goods from two to four metres. They use two basic types of pallets of which one has the same dimensions and construction as those belonging to the Railways and is suitable for transport on main lines and for road transport.

According to information received, it were the Railways who took the initiative to use pallets for external transport by rail. This was done by the *Norwegian State Railways,* the *Swedish State Railways'* committee for Pallet Standardization and the *Netherlands Railways'* subsidiary company Van Gend & Loos. In these countries the clients' main reason in favour of external transport on pallets by the railways is the reduction of the handling cost. In Norway the saving of packing cost seems to be less important. At the Netherlands Railways the parcels have to be well packed and addressed, so that on the whole a reduction of the packing cost is not expected, even if boxpallets are used. An exception is made for a firm whose boxpallets are destined for one consignee.

In these three countries internal palletization by the clients is now marching on, resulting in an increased demand for external palletization with exchange of pallets.

The opposite occurs too. The Railway naturally uses palletization as a means to bind the clients. This can be done in

either case, whether the client uses pallets for his internal transport or not. To overcome the inertia towards the new and untested methods the *Swedish State Railways* carried out a campaign in the spring of 1957, with advertisements, articles in technical journals, films, informative meetings, discussion conferences and visits to clients. The aim of this campaign was to make the clients more « pallet-minded » with respect to the external transports.

At the *Netherlands Railways* the same expedients are used, but ultimate success is mainly scored by visiting the clients who are most suitable. If so wished the entire internal transport and its « link-up » with external transport is thoroughly investigated by the planning experts of the Administration and its subsidiary company and suggestions for improvements are made.

In the Netherlands it occurs that clients use pallets only for the external railway transport. They do so with a view to the profit in the transport of palletized goods from their premises to the railway shed.

A difficulty for the exchange of pallets still lies in a lack of standardization of the pallets. It will take time to overcome this problem. The *Norwegian State Railways,* however, observe that the use of standardized pallets seems to gain ground. At the *Netherlands Railways* the clients who already had pallets for internal transport, before the pallet-exchange came into being, mostly used measurements deviating from the standard measurements 1 000 × 1 200, accepted by the Netherlands Railways. For rail transport the pallets of the Administration's subsidiary company Van Gend & Loos are exclusively used, marked V. G. L. In many cases the client has resolved to execute his entire transport with V. G. L.-pallets. In other cases the packages are transferred to V. G. L.-pallets by consigner in his despatch department or in the depot.

In the latter case there is of course no question of pallet-exchange.

2. Conditions.

37. — *What conditions do you impose and what advantages do you confer on clients sending in palletized consignments?*

Have you introduced a special tariff (give an example) including for example :

- *on the one hand lower (minimum taxable weight) and upper weight limits for palletized loads, conditions concerning the dimensions of pallets and the height of loads?*
- *on the other hand a deduction of the tare weight of the pallets, and their return transport when empty at a reduced rate or free of charge, etc.?*

a) Tariffs.

As was to be expected the conditions at the respective Administrations are all in favour of palletization by the clients.

The *Norwegian State Railways* reduce the gross weight by 20 kg for each pallet; standardized pallets are not charged for on their return-journey to the departure station.

At the *British Railways* the reduction is 56 lbs or 84 lbs (i.e. approx. 25 or 38 kg) according to the size of the pallet. In addition to this free return of empty pallets is provided if it can be proved that they travelled by rail between the same points with a minimum net load of 2 cwts (101.6 kg) for the smaller sized and 3 cwts (152.4 kg) for the larger sized pallets. Subject to special negotiations, pallets of not-standard size may be brought under the same conditions.

As regards boxpallets the same is applicable, provided :

- the pallet-base is one of the standard sizes;
- the sides are collapsible and, when collapsed, fit within the perimeter of the pallet;
- the collapsed boxpallet is not more than 12″ high from the floor.

The *Netherlands Railways* do not charge for the transport of the boxpallet. Transport is exclusively carried out with V.G.L.-boxpallets. When entering into the pallet-exchange agreement consigner buys the number of pallets needed from the Administration's subsidiary company Van Gend & Loos.

For each loaded pallet tendered or collected, consigner immediately receives back an empty (box) pallet in sound condition. The pallets have to be mainly loaded with packages for one « group headstation ».

At the *Swedish State Railways* conditions are somewhat more circumstantial owing to the fact that the client may not palletize on pallets of the Administration. The conditions in question are that the gross weight of the consignment is reduced by the weight of the (box) pallet with a maximum of 25 kg for pallets and 70 kg for boxpallets. Other conditions are:

- that the (box) pallets meet the requirements of the Swedish standard;
- that freight is paid for a weight of at least 150 kg per (box) pallet;
- that all goods loaded on the (box) pallet are to belong to the same consignment and are to be firmly secured to the pallet;
- that the (box) pallet load is entered on the consignment note as being one parcel;
- that every parcel of a pallet load is addressed;
- that the number of supports or detachable sides is entered on the consignment note.

Free return to the outgoing station of (box) pallets, supports and sides is granted in Sweden at almost the same conditions as at the British Railways (see above). Supports and sides have to be collapsible and collapsed. The return journey has to be made within 30 days, and only one consignment of empties for each consignment of loaded pallets. Boxpallets with uncollapsible sides are treated and charged for as used packing.

At the *Soviet Union Railways* the regulations concerning palletized consignments have not yet been worked out.

b) **Facilities.**

39. — *What assistance do you give users in handling their pallets (loan or hire of machines) as well as in making up and labelling palletized loads (supplying staff free or on payment)?*

40. — *Do you make the pallets and pallet-crates stocked by you available to consigners and under what conditions? Are they supplied free of charges, hired out, or put in a pool?*

The *Norwegian State Railways* hire out forklift trucks at a fee of 12 crowns an hour and pallets at a fee of 1 crown a day. For pallets the day of hiring out and the next weekday are free of charge.

The *British Railways* and the *American Railroads* render no assistance with regard to throughout transport of parcels traffic on pallets. At the American Railroads the use of pallets is restricted to the depot platforms.

At the *Soviet Union Railways* pallets are not supplied on demand to the clients. The possibility of introducing this facility in the future is not excluded. The facilities given are restricted to placing at the disposal of all interested parties the experience of the railway and, if requested, free instruction.

The *Swedish State Railways* hire out forklift trucks to railway users at a charge of 20 crowns an hour for trucks with a capacity of 0.9 - 2.3 tons and 30 crowns for trucks with a capacity of 2.3 - 5 tons.

Apart from the pallet exchange the stock of pallets have so far been insufficient to put these at consigners' disposal. Railway pallets arriving loaded with parcels may, however, be loaned for a day to receiver against receipt. If it is returned later half a crown per pallet per day is charged.

At the *Netherlands Railways* pallets are not loaned or hired out to clients. As already mentioned clients sending parcels palletized buy pallets from Van Gend & Loos. Assistance is given for solving problems concerning internal transport and its link-up with external transport.

c) Pallet pools.

42. — *Do you agree on the application of the following principles when pallets are pooled.*

a. *Complete interchangeability of pallets and pallet-crates, and consequently the use by clients of machines identical with those used by your Administration?*

b. *Immediate compensation, number for number, for pallets and palletcrates at the moment the palletized loads are handed over so as to reduce the administrative and control work to the minimum?*

c. *Limitation of the types of machines pooled to the strict minimum so as to reduce the capital investment of your Administration?*

d. *Possibility of progressive introduction?*

Have you been obliged or do you think you will be obliged to agree to mitigations to these principles or to make them more flexible, such as:

— *supply of pallets by the railway for no immediate payment when palletized loads are handed in (mitigation of clause b)?*

— *acceptance of pallets fitted with detachable fastenings (clips, knobs, hooks) or fixed devices of a special character, or even pallets of different sizes (mitigation of clause c)?*

In such a case do you think you can charge sufficient to cover the corresponding costs (returning empties, losses, operating difficulties, etc.).

41. — *If they are pooled, how does this organization function from the technical and administrative angles?*

Give details in particular of the conditions under which pallets are exchanged; are they made immediately, and number for number?

If so, is provision made for payment in kind (supply of pallets by the client) or in cash to cover the railway for the financial charges due to the amortisation of pallets during transport and the corresponding costs when transported empty?

A consequence of general palletization, starting in the factories or dispatch departments of consigners is the formation of pallet pools. In several countries this has been or is being carried out by the Railway Administrations.

An important simplification of the problems inherent in pooling will be acquired by maintaining the principles mentioned in the above question 42. One of the most important conditions undoubtedly is the congruence of the pallets used by the clients and the Railways.

In addition to this simultaneous interchange of loaded pallets with an equal number of empty pallets will reduce to a minimum clerical work and control.

It is important to know to what extent the various Administrations take the same line in these matters.

Well then, the principles mentioned in the question are generally agreed to.

At the *Netherlands Railways* gradual introduction, as meant sub d of the question has taken place in some cases. By this the consigner was able to adapt his working methods to the new system.

The Administration's subsidiary company Van Gend & Loos, who concludes the contracts, refuses to pool pallets with detachable parts and fitted with additional devices, or pallets of deviating sizes. Only pallets and boxpallets marked V. G. L. are pooled. The staff is instructed to supply consigner immediately with a number of empty pallets equal to the number he has tendered loaded with packages. Thus the client always has a constant number of (box) pallets at his disposal. Apart from the written contract and fixing the number of pallets to be supplied no administration is needed.

The *Swedish State Railways* rightly [1] remark that « machines » as forklift trucks are not included in the pool, but only pallets and boxpallets.

Private pallets of sizes other than those agreed upon for the pool or pallets with special devices, cannot be included in the pool since the pool does not provide for their return. According to this Administration it is, on the other hand, conceivable that in domestic traffic the railway should accept consignments loaded on private special pallets. Whether the same concessions are to be granted for such pallets as for standard pallets should be decided for each case separately.

When clients participating in a palletpool despatch a number of loaded pallets they immediately receive in return a corresponding number of pallets either loaded or empty.

The *Norwegian State Railways* are of an opinion that mitigations might be agreed to as regards the supply of pallets without immediate payment when palletized loads are handed in. This Administration says however, that they have too little experience for a definite opinion. In the cases that agreements have been concluded the pallet exchange is regulated in the same manner as in the Netherlands and in Sweden.

The same goes for the *Soviet Union Railways* who requested elucidation of certain terms used, e.g. the term « interchangeability » may be according to capacity, volume or dimensions, but also to suitability for the transportation of one or another type of goods and other factors.

As regards pool conditions the following can be said :

At the *Netherlands Railways* the client buys from Van Gend & Loos the number of (box) pallets he needs for palletizing his parcels traffic by railway and, if necessary, for palletizing his internal transport and storage. Consequently the number of pallets he buys may be considerably smaller than the number he loads daily, because for each lot he dispatches in the course of the day, he receives an equivalent number of empty pallets. On the other hand, it is possible that the client buys considerably more pallets than are to be used for his external transport, because of the stock of pallets used for internal transport and storage.

Pallets are bought for 3 years, boxpallets for 5 years. These periods are based on calculations as regards the life of the pallets. After these periods the client has again to pay the purchase price of the pallets needed.

The *Swedish State Railways* remark that pallet exchange implies the Administration supplying pallets during the actual transport instead of the client and also for the time that the pallets are at the receiver's within the period allowed, unless the receiver also is a participant in the exchange. For this service the Administration receives a certain remuneration from the client. Presumably this observation applies to car-load traffic; as for parcels traffic as a rule railway pallets are used.

The number of pallets which the Swedish State Railways supply to the client, is constituted by the product of the number of loaded pallets despatched daily and the average transport time for the

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[1] They could not know that in the original French version the word « engins » is used, which has not always the same meaning as « machines ».

consignments. The average life of a pallet of the type now used is about three years.

The client may choose between two alternative ways of fixing the remuneration due to the Administration :

1) the client pays the purchase price of the number of pallets supplied when the agreement is concluded and annually one third of this sum as a compensation for the wear and tear of the pallet;
2) the client pays the annual compensation for wear and tear increased by 5 % interest on the capital invested in the stock of pallets supplied to the client.

Only pallets in an undamaged condition may be exchanged, provided with the S. J. mark of ownership. The consigner stamps the consignment notes with the text « The pallets form part of the pallet exchange between S. J. and X. The pallets must be returned to S. J. and not be sent back to consigner ». The incoming depot must see to it that a corresponding number of pallets are immediately delivered by the consignee if he is a participant to the exchange agreement, or check the return of the pallets with the aid of the « Receipt for pallets » if the consignee is not a participant. In the latter case the pallets are to be returned empty at the latest twenty-four hours after the expiration of the period allowed for collection and unloading. Otherwise a forfeit of half a crown per pallet is enacted for each day or part of a day.

At the *Soviet Union Railways* the conditions for the exchange of pallets are still under review. The *Norwegian State Railways* have concluded agreements to the effect that the client is the buyer or hirer of a fixed number of pallets of the Administration.

3. Results.

38. — *What results have you obtained? Have you many clients who ask for or agree to palletize their consignments?*

So far the number of pallet-pool agreements has obviously been rather modest. The campaigns in this direction, however, have only recently started.

At the *Netherlands Railways* this campaign started a good year ago. Now the pallet pool of Van Gend & Loos has 46 participants employing approx. 2 500 pallets and 300 boxpallets, a total investment of about hfl. 105 000.

Also the *Swedish State Railways'* salesmen as a rule have to take the initiative of concluding agreements on the exchange of pallets.

Development with respect to the use of pallets for external transports has hitherto been hampered to some extent by an insufficient stock of pallets. So far agreements have been concluded with about 30 clients.

At the *British Railways* no throughout palletization of parcels traffic is in operation. In respect of full load traffic, however, several firms have signed contracts for palletizing their goods.

The *Norwegian State Railways* have as yet concluded contracts with certain important clients, more and more firms now introduce palletization of outgoing and incoming goods, inviting their clients to make use of pallets.

SUMMARY.

I. GENERAL ASPECTS OF PARCELS TRAFFIC.

The *characteristics* of the parcels traffic supplied by the Administrations correspond in this respect, that parcels traffic is understood to consist of consignments which are less in volume or weight than a carload. The differences mainly lie in the character and extent of further limitations imposed on the consignments or on the packages.

Limitations on the consignments imposed by the Administrations are rare

(Soviet Union Railways); such limitations — minima and maxima —, based on calculations, are imposed by the consigner himself in his own interest. Some Administrations encourage consigners — e.g. by means of special rates — to send full wagon loads.

Limitations on the packages are of a general occurrence but diverge widely; they relate to : volume, dimensions, weight, unwieldiness. Most attention is paid to the maxima. At that it is defining if the package is to be handled by the railway agents or not. If the latter is the case limitations vary from 500 kg up to 20 tons at which, in most cases, it is stipulated that the goods shall not pass through the sheds or shall be loaded and unloaded by consigner respectively consignee. Some Administrations have laid down regulations concerning dimensions, at which a.o. is taken into account the height and width of the wagon doors, the possibility of handling the goods with normal shed equipment, etc.

For the indication of the *importance* of the parcels traffic only the total tonnage of the parcels traffic and the percentage it makes up of the total freight traffic is stated. The percentage varies from 0.3 % (Soviet Union Railways) to 20 % (Eireann Railways). The relative importance in the national economy is not stated, though at describing the *evolution* a connection with the structure and the development of the national economy was noticed. The *British Railways*, the *Norwegian State Railways*, the *Swedish State Railways* and the *American Railroads* report a decline; the *East African Railways*, the *South African Railways*, the *Malayan Railway*, the *New Zealand Government Railways* and the *Soviet Union Railways* report an increase, whereas the *Netherlands Railways* and the *Indian Railways* report that they maintain their positions. Road competition and grouping (consolidating) by forwarding companies are mentioned as the causes of the decline or the standstill.

Though it is perhaps a little far fetched to speak of two different *dispatch* systems it is possible to make a distinction in « regular runnings » and « optional runnings ». As examples of the former the « systems » of the *British Railways* and the *Netherlands Railways* may be mentioned. The main characteristic is that the wagons run according to a fixed schedule and that optional runnings are merely complementary. A minimum permissible weight has been prescribed by some Railways. The organization of the parcels traffic in the Netherlands is strictly « classical » and has, moreover, some particular aspects. As regards the « optional runnings » it is possible to single out two trends. The simple one : running direct wagons to all destinations as soon as a sufficient load can be formed. Examples of this system are : The *East African Railways*, the *South African Railways*, the *Malayan Railway* and the *New Zealand Government Railways*.

Sometimes a prescribed minimum weight is fixed, sometimes it is left to the Agents or the Station-master to decide. If a minimum is fixed this generally amounts to two tons. More complicated is the dispatch system of the *Swedish State Railways*, the *Soviet Union Railways* (expressed in an « Organizational Plan ») and the *Indian Railways*, all three distinguishing 3 categories of parcels wagons.

The Swedish and Soviet systems perhaps approach the « classical organization » most.

Of the aspects of *forwarding* only those stated hereunder are of importance for this study :

a. acceptance for transportation;

b. route-indication of goods and documents;

c. « confrontation » of goods and documents during the transport.

Ad a).

The goods are accepted for transportation accompanied by a consignment note or waybill. Administrations state little

about the particulars to be entered therein. It may be presumed that there are few fundamental differences, but also, that there is no conformity.

The *Soviet Union Railways* demand some kind of entry permit, a typical demand of a « économie dirigée », which though facilitating the planning of the dispatch entails additional clerical work. The administrative work on the documents is mostly done after the checking in the shed, but the *British Railways* execute a preceding detailed registration, in large depots by means of microfilm.

The instructions of the Administrations about the labelling of the goods by the consigner vary little. The majority ask a detailed address of the consignee, as well as marks, numbers and weight. In some cases the address labels are designed by the railway. Little has been reported about checking the goods against the consignment notes. It may be presumed that this is executed fairly alike by all Administrations.

In the Netherlands the parcels of important regular consigners, especially if there are agreements with those consigners concerning flat rates, self labelling with journey labels and palletization are often only counted at checking. Only in exceptional cases some clerical work is done by the checkers.

Ad b).

The route-indications of the various Administrations vary widely, from a few written code characters on waybill and packages to detailed stamping and special labelling. On the waybill a.o. is to be found : serial numbers for identifying the consignment, vehicle guidance, date stamps, « group head station » and destination station, journey schedule, etc., sometimes abbreviated. On the packages : varying from no journey-label at all, to labelling with full or coded name of forwarding and destination station and data concerning the consignment or « station brands »

Ad c).

From the answers it appears that little or no clerical work is done during transport. Those railways, however, who check at transhipment (British Railways, East African Railways, Eireann Railways, Soviet Union Railways, New Zealand Government Railways) report that confrontation of previously made out documents with the goods will have to take place. The *Indian Railways* report that some clerical work is done by the van sorters/guards in the « collecting road vans » during actual transport.

Only the *American Railroads* and the *Netherlands Railways* report that they use *specially designed wagons* for their parcels traffic. The latter supply characteristics of these wagons.

II. THE GOODS DEPOTS.

The *locations* of old depots were defined by factors which, for the present generation, are merely « coincidental » or « historical ». The locations of new depots or of those yet to be built are generally defined by « town-planning » or « regional planning » in which many interests a.o. those of the railway administrations play their part. In existing situations separate locations of incoming, outgoing and transhipment depots sometimes is an intentional adaption to the function, sometimes more or less coincidental factors are the cause of the specialization.

In view of the general *lay-out of the depots* two types may be discerned :

a) *sectional depots,* with separate intallations for incoming-, outgoing and transit traffic;
b) *combined depots,* all installations are used for all three types of traffic; naturally seldom simultaneously, but in succession.

Reporter's impression is that the sectional depot is the prevailing type. At any rate at almost all Administrations the

larger depots are sectional depots. In the Netherlands, on the contrary, the sectional depot is found only very rarely. Very interesting examples of sectional depots are to be found at the *British Railways*, the *Soviet Union Railways* have special container depots. An extraordinary type of sectional depot with further advanced specialization within the divisions is run by the *Indian Railways.*

In the depots of all reporting Administrations the *handling floor* for incoming traffic is a platform. In most cases this is also true for the handling floor for outgoing traffic. Hereby vertical transport is avoided.

The *British Railways* prefer mixed arrangements : platforms in incoming sheds and cartage units in outgoing sheds. The *New Zealand Government Railways* use the mixed arrangement of partly shed and partly yard.

The *Indian Railways'* depots are provided with high level platforms.

The Administrations using platforms, in special cases carry out loading from ground level or from lorry and unloading on lorry. For voluminous or unwieldy goods mobile or stationary cranes or forklift trucks of great capacities are often used.

This working method is the usual procedure in the Soviet Union Railways' « container depots »; it is very seldom applied at the Netherlands Railways. The heights of the platforms vary from 0.61 m (Indian Railways narrow gauge) to 1.23 m (Netherlands Railways) above rail top. Above road level the heights vary from 0.99 m (British Railways) to 1.35 m (maximum of Swedish State Railways).

The answers of the Administrations have enabled reporter to distil but a few general lines concerning *the shape, the area required and the division of the handling floor.* He does think, however, to have been able to derive the following defining factors for the shape, the area required and the division :

— the amount of goods to be handled;
— the ratio in amounts of incoming, outgoing and transhipment goods;
— the number of destinations;
— the number of delivery zones;
— the working method;
— the endeavours to acquire short transport distances;
— the dispatch system;
— uniformity or multifariousness of wagons;
— the existence or non-existence of own pick-up and delivery services.

None of these factors is entirely independent of the others (thus the endeavours to acquire short transport distances and the working method closely cohere; in the same manner there is a coherence between amount of goods, number of destinations and dispatch system) and it may be possible to reduce them to a few general factors (among which the general one often brought on the stage in « explanations » : the structure and the phase of development of the national economy). Neither can all be of influence independently (e.g. the quantity of goods).

With such a multiplicity of defining factors and the complementary or counteracting influences emanating therefrom, it is clear that a proper planning when building or altering of depots is very difficult. When designing important depots it will therefore be necessary, if we are not already tied by too many data, to call in the modern planning technique of « linear programming » to approach an optional solution as much as possible.

The general tendency for shed and platforms in small depots is : long and narrow, in large depots : long for incoming and transhipment shed and platforms, short for outgoing shed and platforms.

III. HANDLING (METHODS AND EQUIPMENT).

Methods.

From the answers to the question about the working methods at forwarding, receipt

and transhipment, it appears, that the handling of the goods takes place in entirely different ways.

At acceptance of the goods at the shed differences arise already in the number of points, where a road vehicle bringing goods has to unload. These differences consequently also lead to differences in the further handling of the goods, because when unloading at several points of the shed a certain pre-sorting of the goods already takes place, whereas when unloading at one point this sorting of the goods has to be done at some other time. The conveyance distances in the shed are also effected by the way of bringing in. For checking the goods widely different methods are applied at forwarding as well as at transhipment and receipt. In one single case there is no control at all at despatch. Where a check is carried out this varies from a comparison of the number of packages tendered with the number stated on the accompanying consignment notes, to all goods being entered in an acceptance book. At transhipment of the goods there are Administrations who do not check the goods at all, and others who keep up a registration of all consignments. Checking at receipt in most cases is done directly when unloading the wagon. For this one Administration makes use of a telephone connection between the wagon and a special checking office, where the waybills are kept. At one Administration the checking is not done at the wagon but when the delivery vehicles are loaded by the delivery man. For weighing the goods most Administrations do have equipment, but do not always weigh goods. This largely depends on the fact if consigner enters the weights on the consignment note.

The further handling of the goods at forwarding, receipt and transhipment depends to a great extent on the equipment employed for handling the goods. Especially palletization, at which the goods are transported in boxes or on pallets, has a revolutionary effect on internal conveyance.

It is a pity that most Administrations do not enter deeply into the working method they apply in their depots.

It does appear, however, that everywhere part of the goods can be conveyed to the wagons directly, whereas another part has still to undergo sorting. One Administration supplies description of the sorting area in which for each destination a box is placed. This Administration, however, tries to have as few goods as possible go via this sorting area to avoid extra handling. Wherever possible the goods are conveyed from the door where the goods are accepted directly to the wagons; also consigners are urged to presort the goods already when making these ready for dispatch. At receipt as well a difference is made between goods which are directly conveyed to the delivery vehicles and goods which undergo sorting before being conveyed to the delivery vehicles.

Equipment.

As already observed in « Methods » the forklift truck is a very important facility in the depots, which, however, is not yet introduced by all Administrations. The lifting powers of the trucks in use vary from 900 kg to 2 000 kg, which is probably due to the different kinds of goods to be conveyed. The development of the forklift truck itself, however, has not yet come to a standstill. Various Administrations are still making experiments to ascertain the best type of forklift truck. The struggle is mainly between electric trucks and trucks with internal combustion engines. The electric trucks have the drawback that the operating time of the batteries between charging is too short, whereas the exhaust gases are inconvenient. Experiments, however, seem to result in favour of the trucks with internal combustion engines. It is striking that one Administration practically have no damage to forklift trucks, whereas other Administrations meet with a lot of trouble in this respect. Besides the forklifttruck there is

a great variety of equipment both powered and non-powered. At this it is remarkable that still experiments are carried out with different kinds of one of the simplest pieces of equipment, the wheelbarrow. The equipment with greatest capacity is to be found in the cranes. One Administration even mentions the employment of a crane of 65 tons capacity. Special facilities for sortings such as sorting tables or something of the like are not used.

IV. PROBLEMS INHERENT IN DISTRIBUTION.

This chapter was dealt with summarily. Five of the twelve Administrations who replied to the questions have no own collection and delivery service.

The kinds of vehicles used vary from covered 1 ½ tons vehicles to semi-trailers (either covered or not) of 15 tons. The special equipment for the loading and unloading of heavy parcels, small containers, etc. for the greater part consists of small cranes with a lifting power of 1 ½ tons mounted on the vehicles. Two-wheeled floats with a very low floor are also used for this purpose.

Delay at receipt mostly affects the punctual execution of the delivery service. In many cases the delivery service makes several rounds a day. A delay at unloading in these cases not always results in the goods being delivered a day later. At the collection service too operations are mostly synchronized, but a delay at collecting need not always lead to a delay in the departure of trains.

Placing in the shed the incoming goods which have to be delivered is usually done in sections on the shed floor corresponding with the delivery districts. An exception to this is the direct loading on semi-trailers (*British Railways*). Goods which are uplifted by the consignees are stored in the shed, sometimes according to despatch stations (*Indian Railways*), frequently in coded sections, the code indications of which are noted on the waybill, and sometimes on special sections for big consignees (*New Zealand Government Railways*).

What preliminary sorting is done by the collection service a.o. depends on the way in which the goods are accepted in the shed. In those cases that there are more points of acceptance in the depot the driver loads the goods as much as possible per point of acceptance. In other cases the goods are put together in the depot per consigner to facilitate control. It also occurs that the driver, while collecting the goods, places these per destination station in the cartage vehicle. Another possibility is that the driver does not pre-sort and loads the goods arbitrarily in the cartage vehicle.

Loading the cartage vehicles in a few cases is done by the depot staff, sometimes based on a permanent programme, sometimes according to the driver's instructions. When the cartage vehicles are loaded by the shed staff it is difficult to check the consignments against the invoices, waybills, etc. The check is then mostly made by consignee, while it also happens that the goods are delivered and that consignee has to complain if the consignments are damaged or incomplete.

As regards the apportioning of responsibility between shed staff and delivery service, mostly that party is responsible who has accepted the goods without protest. Hence when the goods are loaded by the delivery man, the delivery man will be responsible if he has not reported irregularities when loading.

V. PROBLEMS CAUSED BY THE PALLETIZATION OF THE PARCELS TRAFFIC.

To the questions put in this part naturally only answers have been received from Administrations who make use of pallets. At various Administrations, notably those in the preponderantly agricultural countries this is not the case. At some Admin-

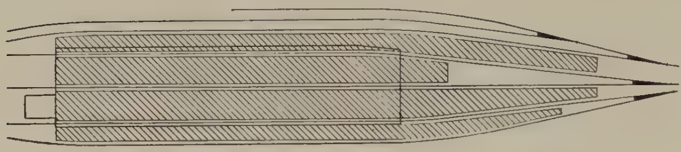
istrations in the more industrial countries palletization is still at a stage at which experiments are made. Some Administrations already dispose of an experience of many years' standing with the use of pallets. In the latter cases as well palletization is still in its development. Recently the pallet system was still used almost exclusively by these Administrations as an expedient at the conveyance in the sheds, at loading and unloading the wagons and, in consequence, at the transport by rail. Of late years, the development tends towards general palletization, to be understood as palletization covering the whole chain of transport, from one end to the other and including both consigner and consignee. This form is recognized to be the most expedient. A difficulty, however, is that with parcels traffic the greater part of the consignees receive only very small lots at a time so that there is no sense in transporting palletized from the depot to consignees' premises. Throughout palletized transport of consignments from consigner to consignee will consequently only seldom be reached. As far as particulars have been supplied on this matter by far the greater part of the packages prove to be suitable for transport on pallets. In order to better adjust to each other the measurements of packages and pallets measures are devised or considered here and there. Only one Administration makes use of boxpallets to a large extent. Of course palletization effects the procedure in the depot. At this it is of special importance that the use of pallets has considerably contributed in realizing the switch-over from manpower to mechanic power, thus creating more favourable working conditions. Consequently the reactions of the staff to palletization are in general favourable. General palletization has an unfavourable effect on the ratio of loading of the wagons. The extent of this effect is connected with the density of transport and the absolute size of the average load. The influence of this factor on the economic results varies with the distance over which has to be transported. At distances upwards of 300 km palletized transport does not seem to throw off profits. Palletization in international transport, therefore does not seem recommendable, at any rate not for parcels traffic, even without considering the problems adherent to international pallet pools.

These problems also play an important part at the conclusion of pallet exchange agreements between the Administrations. These agreements are a necessary condition in order to reach throughout palletization. The most important problem at this is a complete interchangeability of the pallets, necessary to reduce to a minimum the clerical and control work inherent in the pooling of pallets. This presupposes standardization of the measurements of the pallets and reduction of the number of types.

At the transport on pallets from consigner to consignee there is still the problem that the cartage vehicles which have to be used for the transport between consigner and depot and between depot and consignee are mostly restricted to certain measurements which stand in the way of a good utilization of the loading capacity with pallets.

Data about the economic results are rather scarce. The principal motives for the introduction of palletization rather seem to lie in the desire to render more attractive the working conditions for the depot staff and in the possibility palletization offers for supplying a link-up with the internal transport of many consigners who have embarked upon palletization or will do so yet. In this respect palletization is the most obvious form of mechanization and it will undoubtedly find further expansion in the near future.

HALLSBERG : the transhipment shed.



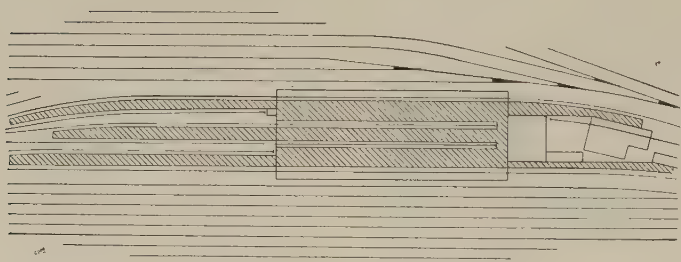
October 1956 : production per day and man : 1.7 vans 118.2 cly).

Appendix 1 *a*

Swedish State Railways.

(II - A)

NÄSSJÖ : the transhipment shed.



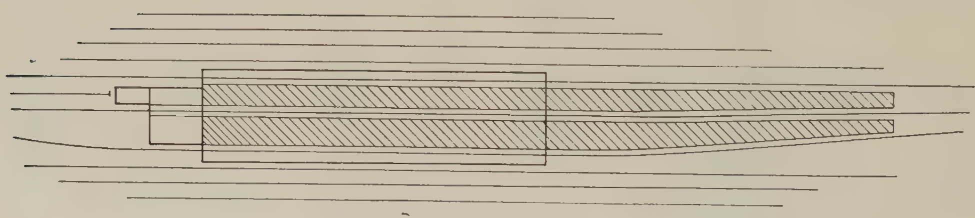
October 1956 : production per day and man : 1.5 vans (103.7 cly).

Appendix 1 *b*

Swedish State Railways.

(II - A)

ÅNGE : the transhipment shed.



October 1956 : production per day and man : 2.5 vans (159.1 cly).

Appendix 1 *c*

Swedish State Railways.

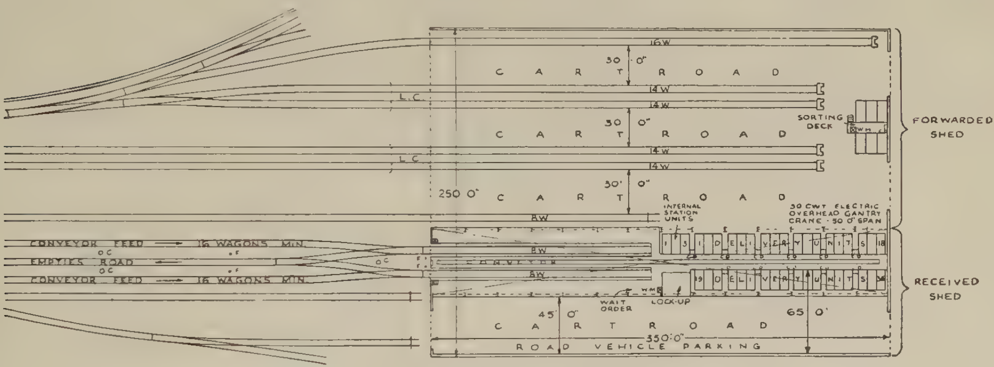
(II - A)

SUNDRIES SHED
SLAT CONVEYOR AND DIRECT LOADING LAYOUT.

Reference

°C Capstan.
°F Fairlead.
L.C. Level crossing.
W.M Weighing machine.
C.D. Suitable site for checkers desk if required.

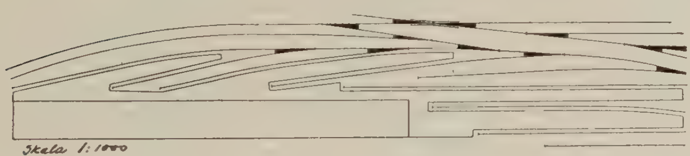
25 cwt battery electric mobile crane provided in forwarded shed.



Appendix 2 *a*

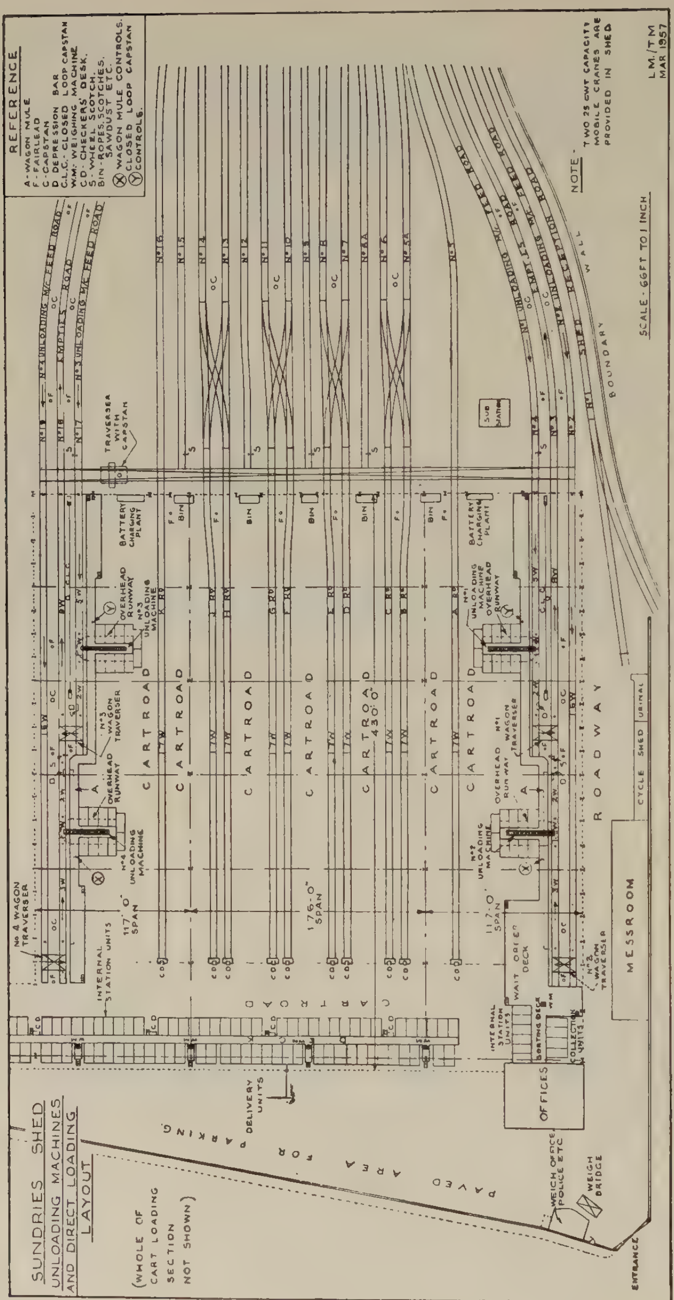
British Railways.
(II - B - 1)

HÄLSINGBORG : the freight goods depot.



Appendix 3 *a*

Swedish State Railways.
(II - B - 1)

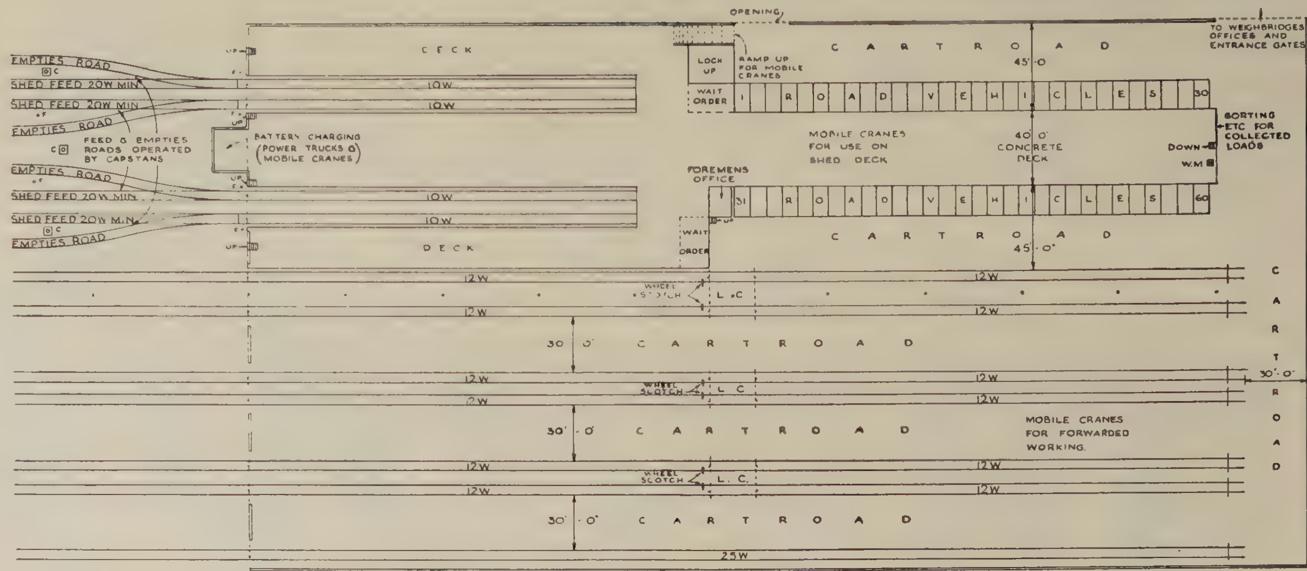


Appendix 2 b

British Railways.
(II - B - 1)

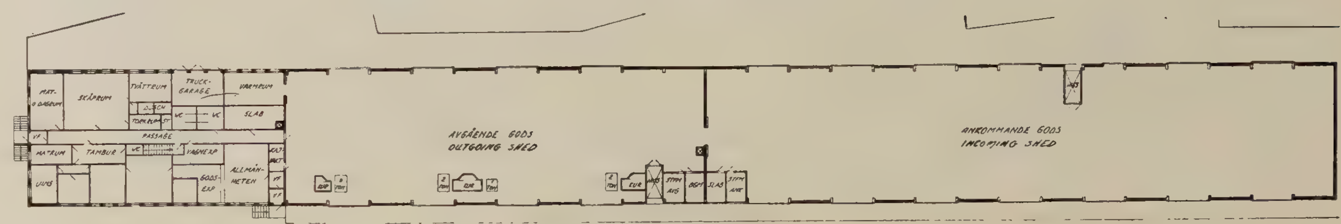
SUNDRIES SHED
POWER TRUCK AND DIRECT LOADING LAYOUT.

L.C. = Level crossing.
F. = Fairlead.
C. = Capstan.
Portable checkers desks to be provided as necessary.



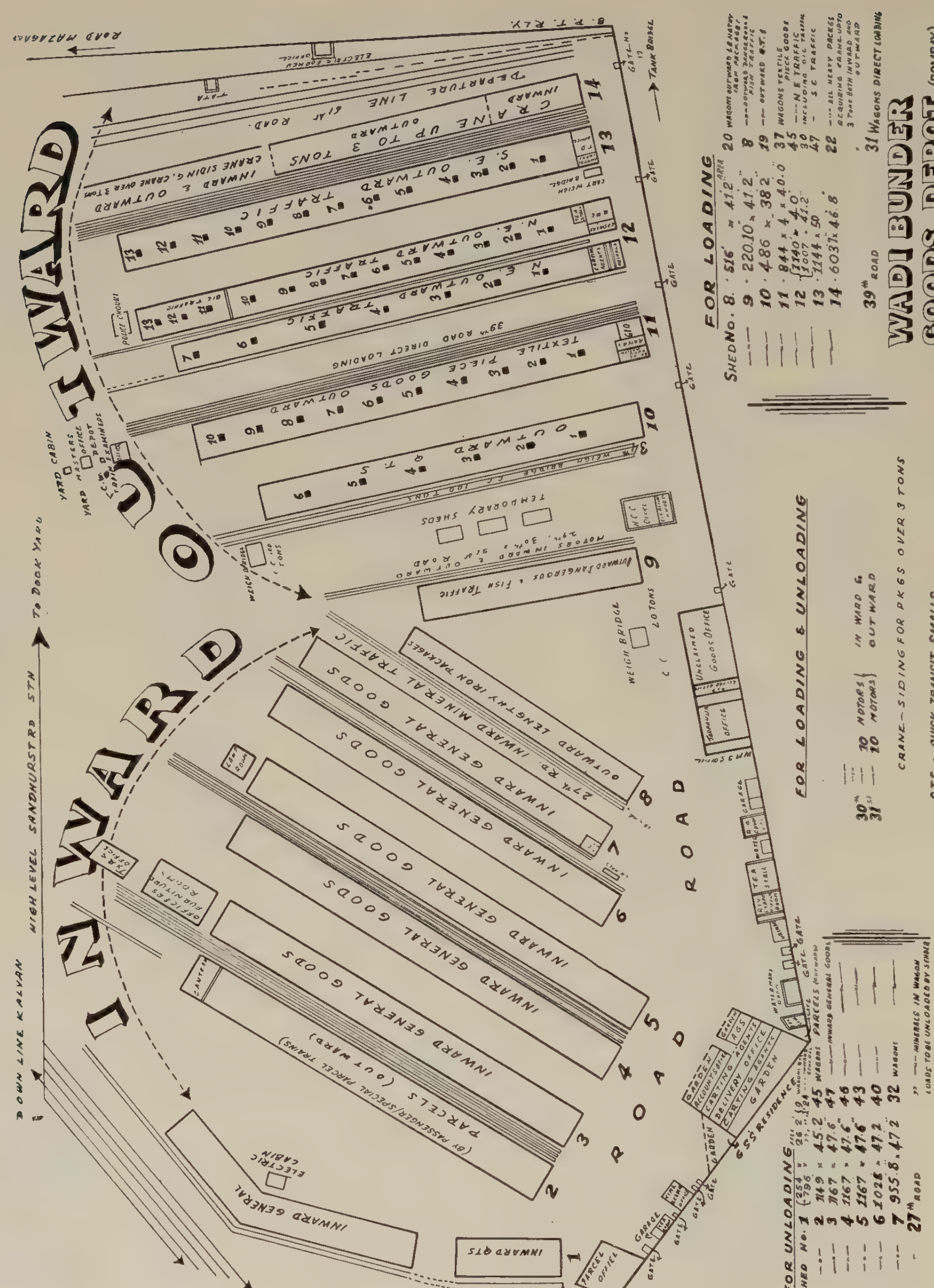
Appendix 2 *c*
British Railways.
(II - B - 1)

HÄLSINGBORG : the freight goods depot.
October 1956 : 857 outgoing vans — 760 incoming vans.



Appendix 3 *b*
Swedish State Railways.
(II - B - 1)

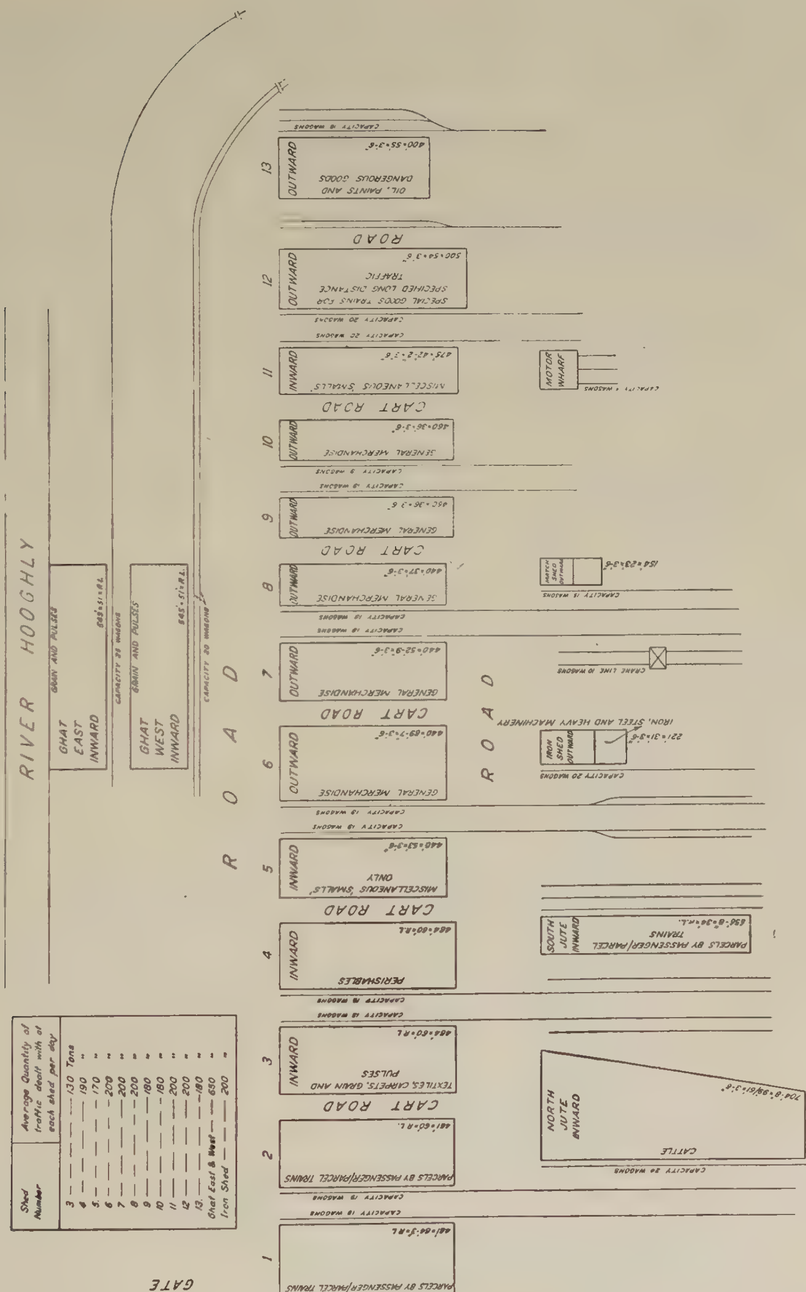
INDIAN RAILWAYS
(Central Railway)



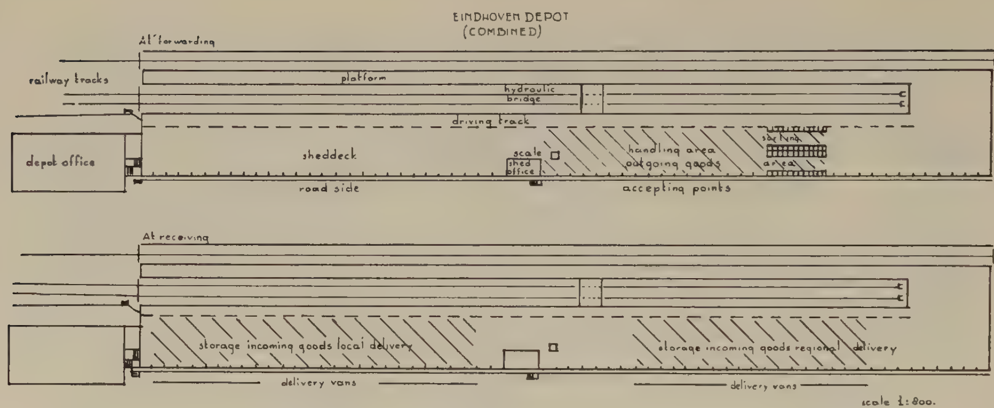
Appendix 4 a
(II - B - 1)

INDIAN RAILWAYS

Howrah goods shed (Eastern railway) (Calcutta)



Appendix 4 *b*
(II - B - 1)



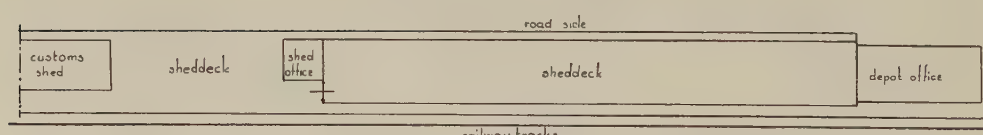
Appendix 5 *a*

Netherlands Railways/Van Gend & Loos (II - B - 1 and III - A - 1/2).

Put into use :	January 1956		
Measurements :	sheddeck 200 × 15 m = 3 000 m²		
	platform 200 × 3 m = 600 m²		
Number of wagons :	at receipt 54.		
	at forwarding 84		
Turnover :		incoming	outgoing
	tonnage	210	240
	consigments	3 000	4 000
Number of vehicles :	27 delivery vans		
	8 trailers		

AMERSFOORT DEPOT

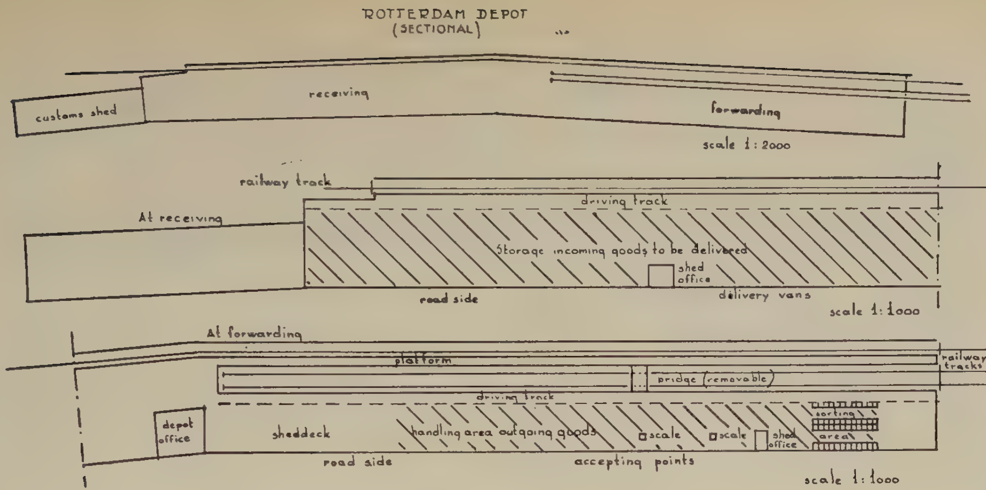
(Combined)



Appendix 5 *b*

Netherlands Railways/Van Gend & Loos (II - B - 1).

Put into use :	1 900		
Measurements :	sheddeck 112 × 14 m = 1 568 m²		
Number of wagons :	at receipt 41		
	at forwarding 48		
Turnover :		incoming	outgoing
	tonnage	180	160
	consignments	2 400	2 000
Number of vehicles :	28 delivery vans		
	12 trailers		



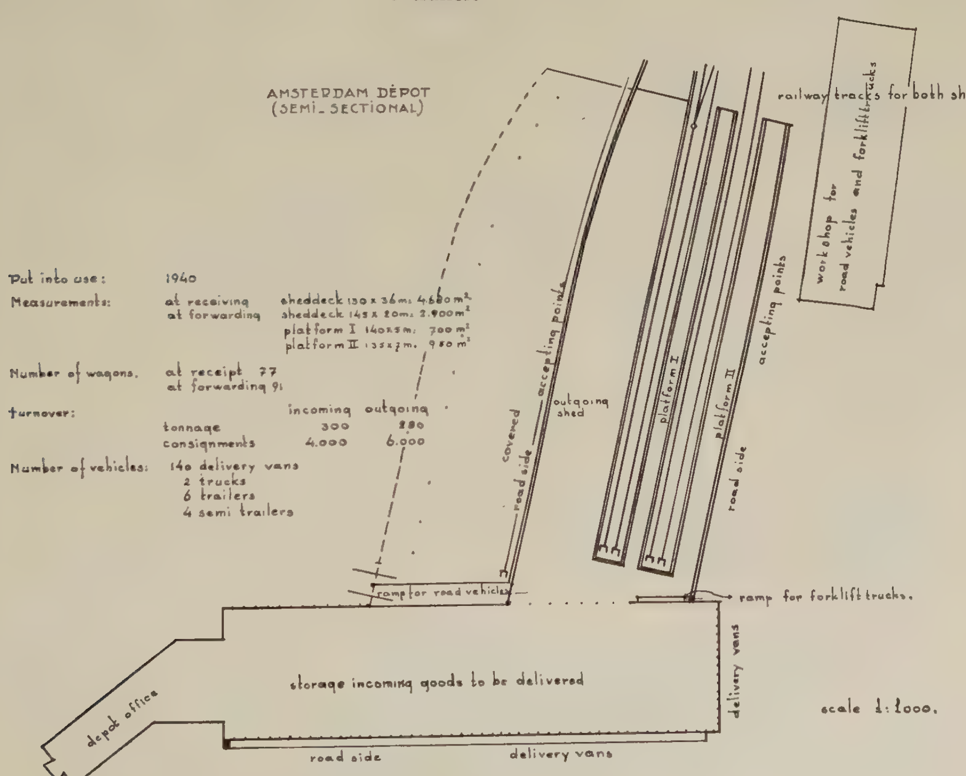
Appendix 5 *c*

Netherlands Railways/Van Gend & Loos (II - B - 1).

Put into use :	May 1953	
Measurements :	at receiving :	sheddeck 200 × 28 m = 5 600 m²
	at forwarding :	sheddeck 210 × 17,5 m = 3 675 m²
		platform 210 × 3 m = 630 m²
Number of wagons :	at receipt 84	
	at forwarding 72	

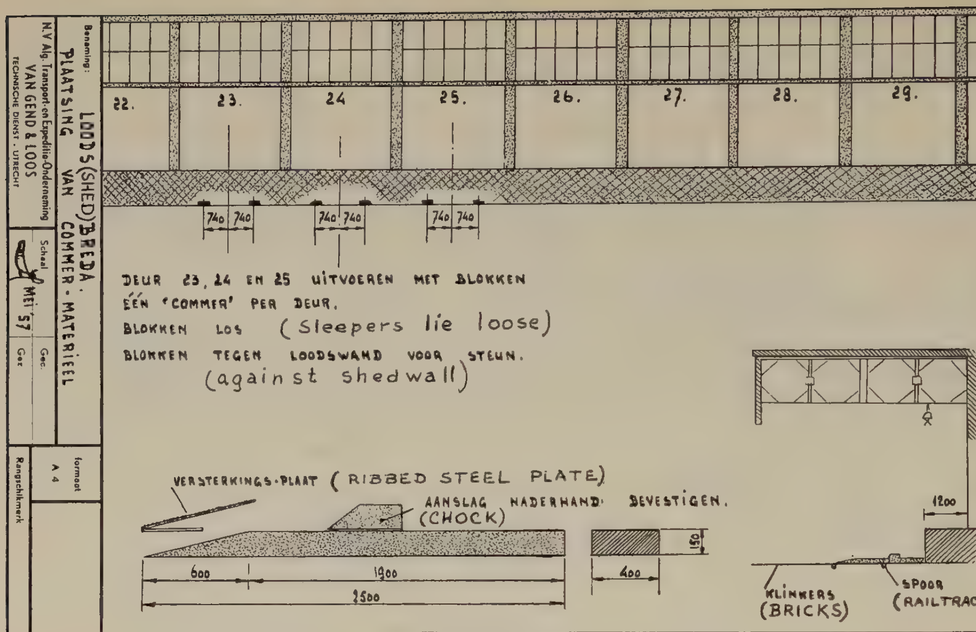
Turnover :		incoming	outgoing
	tonnage	300	270
	consignments	4 000	3 600

Number of vehicles : 98 delivery vans
9 trailers

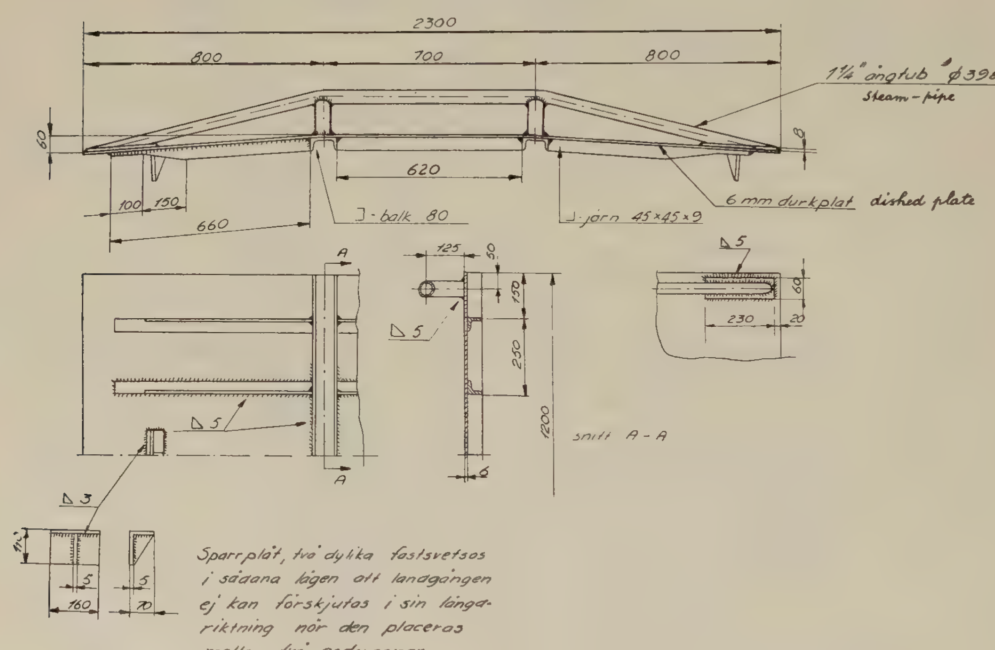


Appendix 5 *d*

Netherlands Railways/Van Gend & Loos. (II - B - 1 and III - A - 1/2)

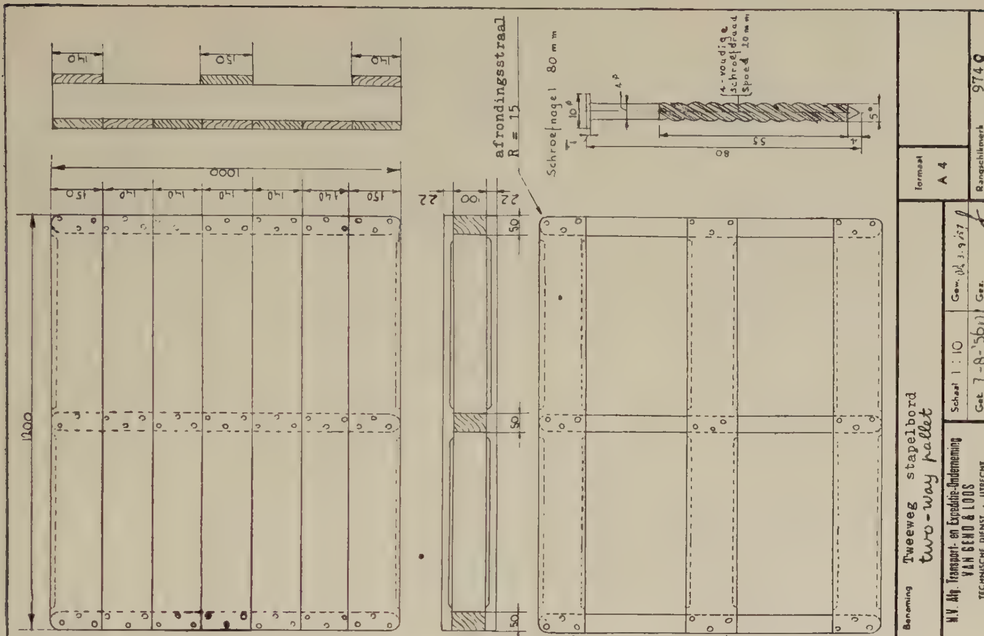


Appendix 6
(II - B - 2 *a*)



Appendix 7
Swedish State Railways
(II - B - 2 *b*) — List Question 8.

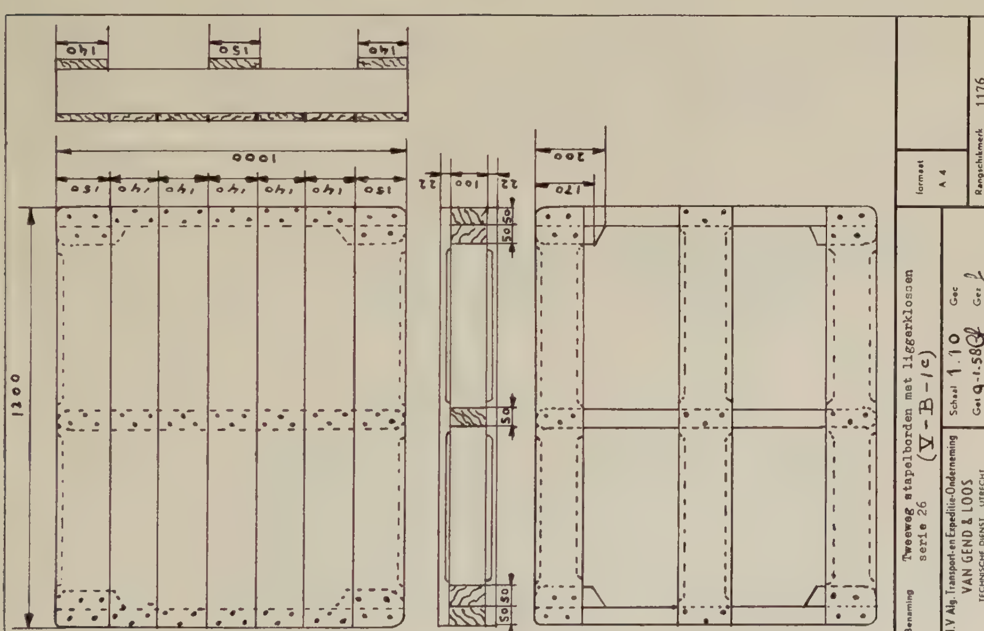
Explanation of the Swedish wording : Sparrplåt, två dylika fastsvetsas i sådana lägen att landgången ej kan förskjutas i sin längdriktning när den placeras mellan två godsvagnar = blocking plate, two firm ones, welded in such a position that the ramp cannot be moved lengthwise when being placed between two goods wagons.



Appendix 8 *a*

Van Gend & Loos

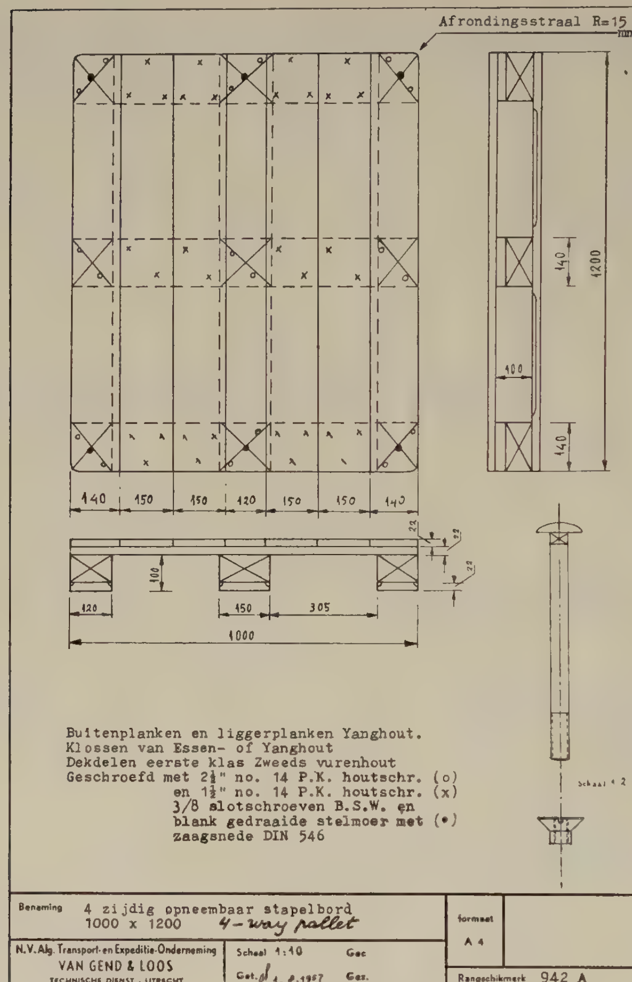
Normal 2 - way pallet (V - B - 1 *a*).



Appendix 8 *b*

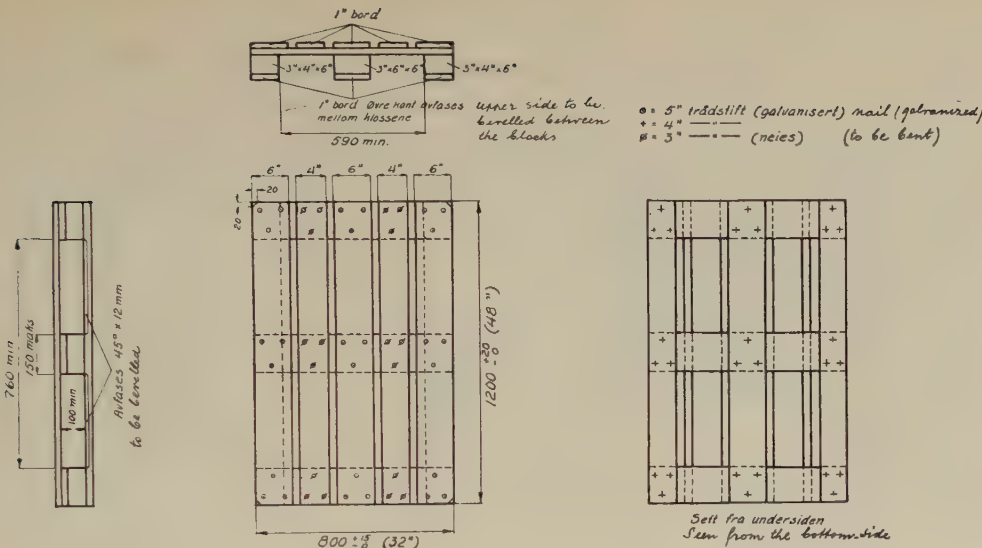
Van Gend & Loos

Reinforced 2 - way pallet (V - B - 1 *a* and *c*).



Appendix 8 *c*
Van Gend & Loos
Normal 4 - way pallet (V - B - 1 *a*)

Explanation of Dutch wording : Buitenplanken en liggerplanken Yanghout. Klossen van Essen- of Yanghout. Dekdelen eerste klas Zweeds vurenhout. Geschroefd met 2½" no. 14 P.K. houtschr. (o) en 1½" no. 14 P.K. houtschr. (x). 3/8 slotschroeven B.S.W. en blank gedraaide stelmoer met (.) zaagsnede DIN 546 = outer boards and stringer boards of yang-wood. Blocks of ash-wood or yang-wood. Deckboards of first class Swedish white deal screwed with 2½" no 14 gauge screws and 1½" no 14 gauge screws. 3/8 bolt BSW and machined fixing nut with saw-cut DIN 546.

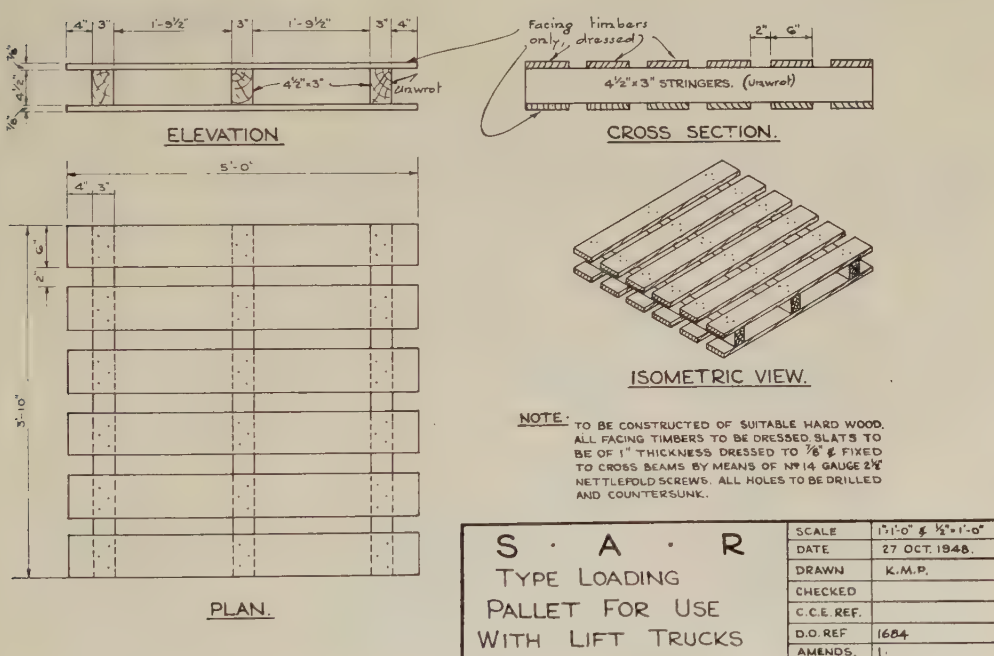


Appendix 9

Norwegian State Railways.

4 - way pallet according to Norwegian Standard 815 and 816.

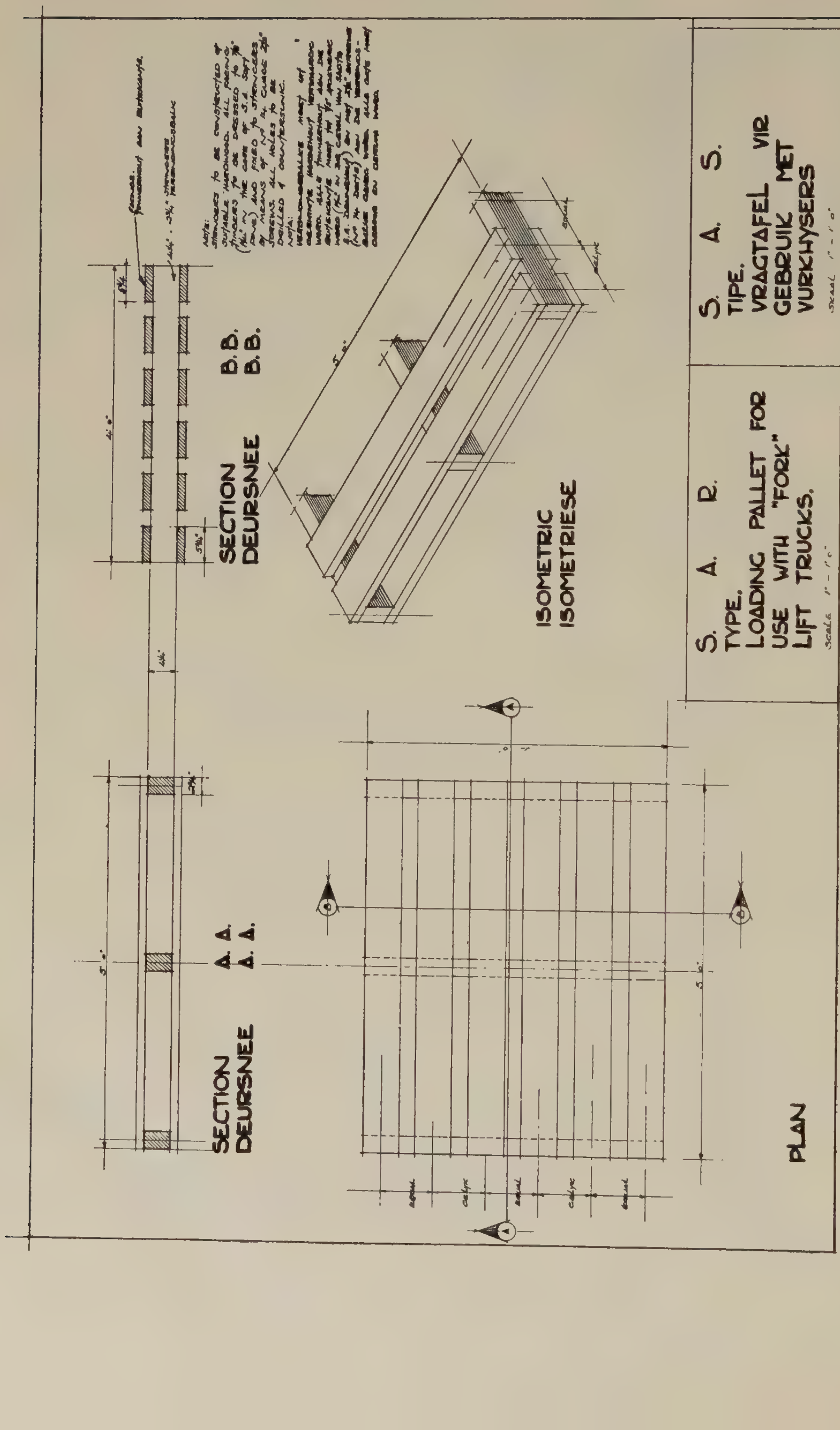
Note : The wood shall be unplaned, dry and of good quality. The outer boards ought to be free from knots and of closely grown red deal.
The fibre of the blocks should run horizontally. No nail head sticking out from deck and bottom surface may appear.



Appendix 10 *b*

South African Railways.

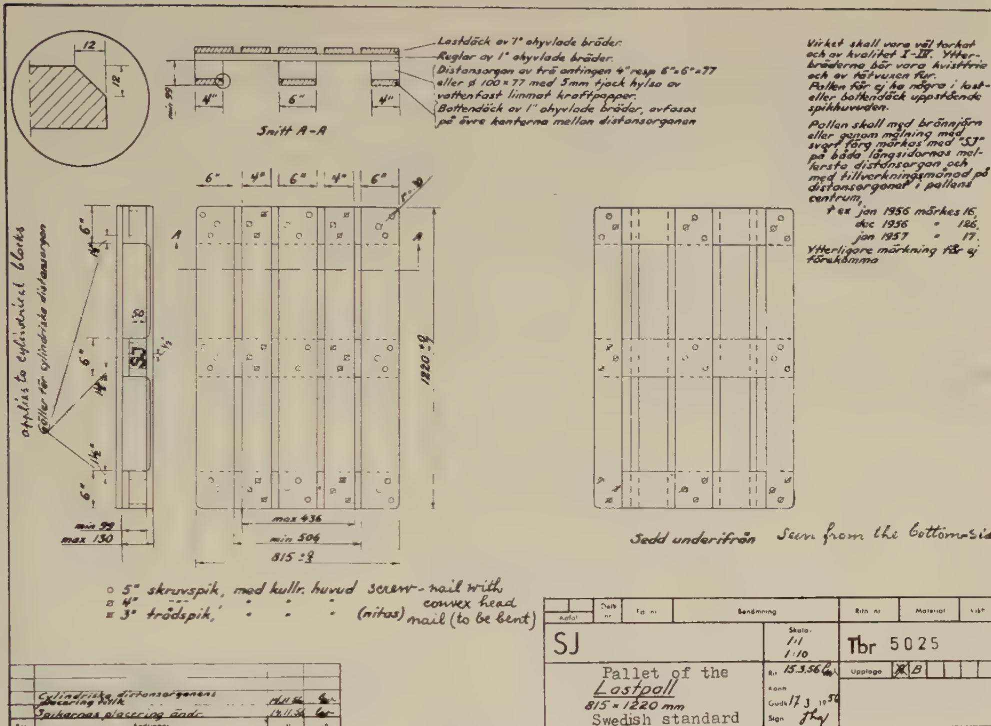
Two - way double decked winged pallet.



Appendix 10 *a*

South African Railways

Two - way double decked pallet (V - B - 1 *a*)



Appendix 11

Swedish State Railways.

Explanations of Swedish wording : Virket skall vara väl torkat och av kvalitet I - IV. Ytterbräderna bör vara kwistfrie och av tätvuxen fur. Pallen får ej ha några i last- eller bottendäck uppstående spikhuvuden. Pallen skall med brännjärn eller genom målning med svart färg märkas med « SJ » på båda långsidornas mellersta distansorgan och med tillverkningsmånad på distansorganet i pallens centrum,

t ex jan 1956 märkes 16,
dec 1956 » 126,
jan 1957 » 17.

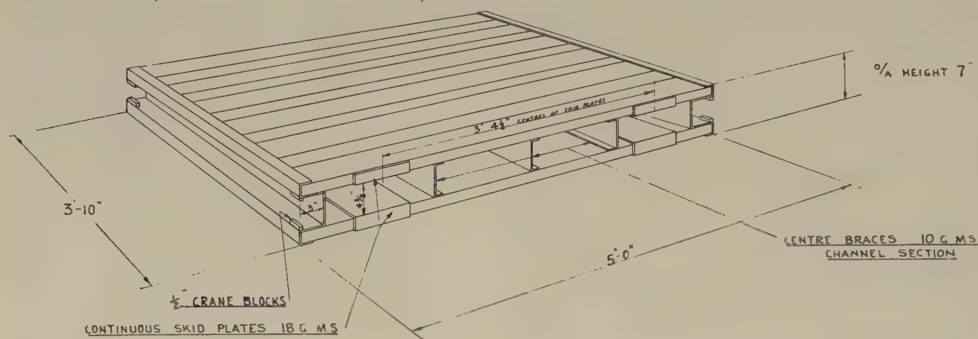
Ytterligare märkning får ej förekomma = the wood shall be properly dried and of quality I - IV. Outer boards ought to be free of knots and made of closely grown red deal. There may not be one single nail head sticking out from the deck or bottom surface of the pallet. The pallet has to be marked « S.J » with a branding-iron or by painting with black paint on the middle blocks at the two long sides and the month of manufacture on the block in the centre of the pallet.

e.g. January 1956 is marked 16.
December 1956 is marked 126.
January 1957 is marked 17.

Further markings are not allowed. — Lastdäck av 1" ohyvlade bräder. Reglar av 1" ohyvlade bräder. Distansorgan av trä antingen 4" resp 6" × 6" ×77 eller diam. 100 × 77 med 5 mm tjock hylsa av vattenfast limmat kraftpapper. Bottendäck av 1" ohyvlade bräder, avfasas på övre kanterna mellan distansorganen = deck of 1" unplaned boards. Stringer boards of 1" unplaned boards. Blocks of wood either 4" respectively 6" × 6" × 77 or diam. 100 × 77, 5 mm cover of waterresistent sized kraftpaper. Bottom deck of 1" unplaned boards bevelled on top side between the blocks.

6-channel section slats 5 wide top & bottom 16 G.M.S.
(5" surfaces to be outside)

Winged - side frames 14 G.M.S.



Appendix 10 *c*

South African Railways.

S.A.R. Type steel double decked, winged pallet
Two way - entry for cargo handling.

Note. — Pallet to be stressed for use with fork lift & jib crane.

[385 .11]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 8.

Financing and conserving railway properties and assets.

Study and comparison for limited companies, partially state-owned companies and State Railways, of the financial means used for the normal renewal of installations and rolling stock.

Forms of amortisation and renewal, taking into account for the latter, the slow or speedy depreciation of the currency.

REPORT

(Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Western Germany, Greece, Hungary, Indonesia, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Viet-Nam and Yugoslavia),

by W. Keller,

Chef de section du Contrôle des finances et de la comptabilité générale des Chemins de fer fédéraux suisses, Berne.

This report is based on the replies given by Railway Administrations to the questionnaire issued by the International Railway Congress Association. The replies show that, from one country to another, the legal and economic conditions are widely different, as also are the methods of accounting. If we had tried to take all the replies into account, the report would have become voluminous.

Moreover, we have had to amplify or clarify the replies received by asking for further details and even paying visits for discussions. We have been able to do this with a limited number of Administrations. We shall therefore mention in our report only those Administrations with which we have had such discussions, and offer our apologies to other Railways if we do not refer to their reply. We have, however, been able to verify that these Administrations have resolved the problem in a similar manner.

The statements of the following Administrations have been taken into consideration in the report: German Federal Railways (DB), French National Railways (SNCF), Italian State Railways (FS), Belgian National Railways (SNCB), Netherlands Railways (NS), and the Swiss Federal Railways (CFF).

In the present investigation, we deal

only with invested assets. Mobile assets have only a secondary role rate in railway finance.

1. CONSERVATION OF ASSETS AND CAPITAL : COMMERCIAL THEORY AND PRACTICE.

Any undertaking which produces goods or provides services, needs equipment or tools such as machinery, buildings, vehicles etc. To survive, the undertaking must constantly conserve the substance of its productive equipment.

To buy the equipment, money is necessary, i.e. capital. The investor supplying the funds expects that the money invested will produce revenue and that it can one day be recovered at least at par. If only for this reason, it is necessary for the undertaking to conserve the substance of the investment, which is the counterpart of the capital investment.

Capital assets are, however, subject to annual depreciation as a result of wear and tear, rust, or age in relation to other more productive equipment. If a loss of capital is to be avoided, the undertaking must offset this depreciation as it occurs. This means firstly an accountable compensation. This is only translated into physical replacement when the equipment becomes unusable. The financial arrangements, accounts and cost calculations cover the depreciation by amortisation funds. The calculation of the first cost allows the fixing of the selling price which covers the costs. At the end of the year, comparing the charges and incomes from production, it can be seen whether the costs have been covered. The allocation to reserve for this prevents the amount of depreciation being shown as a dividend for distribution.

So long as money retained its value, the problem of amortisation funds was limited to the most accurate assessment possible of the useful life of the investments and the allocation of the amounts needed for amortisation in the different years (constant, decreasing or progressive sinking funds). The amortisation funds were functions of the purchase price of the assets. If the undertaking recovered this purchase price by sinking funds it could, at the end of the usable life of the assets either repay the capital or buy new equipment of the same value. Capital and assets were thus maintained integrally.

This, however, was changed as a result of the currency depreciation in all countries. We are thinking here less of monetary devaluation due to inflation, than to the slow reduction in purchasing power which has affected even those countries with a strong currency. For example, since 1938, the index of wholesale prices has more than doubled in the U. S. A. and in Switzerland.

When the purchasing power of money falls, redemption at the purchase value allows the undertaking to repay the nominal capital when the equipment becomes unserviceable; but it does not allow for its replacement. The nominal capital, but not its substance, has been conserved. What is important, however, is not the repayment of the capital but the replacement of the assets. The undertaking which wishes to survive is therefore confronted by the following fact : if, having worked with the old « cheap » equipment, it has considered that a part of the income can be considered as profit and distributed to the shareholders, it follows that these sums will not be available for the renewal. It must then call for new capital. In these conditions, however, it would have difficulty in raising it, at least under favourable terms. In addition, it risks seeing its financial position deteriorate because it is not sure that income will cover the charges on the increased capital.

In commercial practice as well as theory, it is agreed that the investments needed for conservation of assets alone must be assured by auto-financing, that is by the product of operation.

In this respect, theory calls for arrange-

ments to redeem the replacement cost. By replacement cost, it is necessary to consider either the present-day value, i.e. at the time the redemption amounts are assessed, or the renewal cost. It is necessary to disregard the renewal cost for two reasons. Firstly, it is difficult to determine in advance. Secondly, it can scarcely be justified. Whilst it is desirable that the railway user should pay the redemption cost of the equipment and stock of vehicles at its current value, it seems unjustifiable to ask him to pay a price which takes account of a possible future depreciation of money value; the user's revenue, moreover, is in the current money value.

The amount of redemption calculated at the prevailing values does not correspond to the true replacement value. It is obvious that when the purchasing power of money falls, it becomes theoretically impossible to recover the investment by auto-finance. In practice, however, as we shall show, redemption calculated on current values will generally suffice.

Although the prevailing value may be the time value, this is difficult to calculate when related to assets which have no fixed market price as ordinary goods have. They are separate and often unique items which will not again be produced. Moreover, replacement will generally include betterment. Steam locomotives are, for example, replaced by diesel or electric locomotives of greater capacity. In good practice, it is not possible to base renewal charges for steam locomotives on the price of diesel or electric locomotives, even though it appears desirable to cover by revenue financing the supplementary costs incurred by the higher power of the new vehicles. It would be necessary to calculate the renewal charge more on the present purchase price of identical steam locomotives. This theoretical replacement value is obviously not easy to specify and its determination is to a great extent an estimate.

In spite of these difficulties, commercial practice in certain countries (Netherlands, France) allows the principle of renewal charges at prevailing value. This system has scarcely penetrated other countries, mainly because the Fiscal Authorities do not recognise it. In these countries, industry uses other ways of preserving its substance; it certainly bases renewal charges on the initial purchase value, but gives a very conservative estimated useful life to equipment; in other words, it provides excessive renewal charges. According to a German statement, renewal charges in industry reached in 1955 for example, 18.8 % of the accountable value of assets. By the use of a decreasing rate for the renewal charges, mainly in the form of redemption of the book value, the major portion of the renewal cost is borne during the earlier years of use. According to the same German statistics, it is possible in this way to redeem 60 % of the purchase price in the first three years. This accelerated redemption does not produce more than the prime cost of the assets. It does, however, considerably facilitate the financing of investment for replacement and extension. In general, because of the varying ages of the assets and development of technique, the reserve funds provided for redemption are being used regularly for renewal and improvement. Thus, each year, there are new increases in assets, paid for by the very high proportion of early renewal charge. According to the calculation of an author [1], the reducing annual charge — provided that prices do not change — allows the financing of a 50 - 60 % increase in production so long as the renewal charges are re-invested concurrently. Instead of increased capacity, increased renewal cost of a similar amount can be covered in the same way.

Finally, in commercial practice, provision is made, at least in good years, for a generous allowance to maintenance; as such expenses which constitute increased capital value are often classified in this way.

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[1] Karl HAX : « Die Substanzerhaltung der Betriebe , Westdeutscher Verlag, Köln.

In brief, it is noted that in all countries, industry provides sinking funds to the permissible extent for conserving its assets by auto-finance. The conception of retention of assets is widely defined; it comprises not only the replacement of capital equipment by other items of the same value, but also their modernisation and development as called for by progress in technique. Some undertakings even finance actual extensions in capacity from their own resources. Without this auto-finance, the immense growth of productive equipment recorded over the past few decades would hardly have been possible.

II. CONSERVATION OF RAILWAY PROPERTY AND CAPITAL.

1. General.

The maintenance of Railway property is subject to economic laws identical to those governing industry. It may be noted, however, that there are some special features. The problem is particularly important in Railways. Renewal and maintenance represent 24 to 43 % of the total charges of modern systems. Excessive or inadequate amortisation has wide financial repercussions.

Moreover, fixed installations have, in general, a very long useful life. In permanent way, for example, renewals are often carried out piecemeal, as needed, whilst other equipment, the body of the track and tunnels particularly, are practically never renewed. Depreciation is thus less obvious and is difficult to compute. Monetary depreciation too, makes itself felt particularly with very long lived assets.

The essential difference, however, is in the nature of a public service held by the railway. This means that the State has a more or less marked influence on its general policy. It obliges the railway constantly to maintain its equipment in good condition, to adapt it to the requirements of the traffic and technical progress. At the same time, however, as it imposes on the railway duties of various kinds, it often prevents the railway from ensuring from its own resources the essential funds. The degree of Government influence is reflected in the accounts; the greater the influence the worse are the results and vice versa.

However, the deficits should not prevent the railways from carrying the whole of the amortisation or cost of renewal in their accounts. If they do not, they err themselves, as well as deceiving the public. It is then only at too late a date found that the railway has been living on its assets. The only thing left is to render the enterprise wholesome; the sons will thus have to pay for the mistakes of the fathers.

The State, which sooner or later will have to take over the railway deficits, succumbs too easily to the temptation to reduce them by restricting the charges for redemption or renewal. It exerts this pressure either directly by fixing or approving the amortisation or renewal rates, or indirectly by approving the budget. There is a certain parallel with industry in relation to Fisc. The State wants low amortisation in private industry to impose the highest possible taxes on dividends, but with the railway to reduce as much as possible the deficit it will have to carry in the final account. There is, however, the difference that pressure on the railway is more effective. The State has, in the first place, the right to inspect and impose statutes on it. In addition, the railway managements very often are not inclined to resist this pressure because they are obviously not anxious to present debit balances. Finally, there is also the weight of taxation which, in private industry, is reflected only in the final balance sheet, which does not prevent them from including very high amortisation rates in their accounts.

If the deficits are not covered concurrently entirely by the State, even with sufficient sinking funds, the fact will remain that there will be insufficient resources to conserve the assets. They will then be

faced with an empty cash box, which will enforce the restriction of maintenance and renewal.

2. The various accounting methods.

Of the six Administrations concerned in our investigation, only two — the *NS* and *CFF* use the standard method of amortisation. The other four use the « *fixed value* » *method* of accounting.

According to this method, instead of the calculated amortisation costs, the actual renewal costs are charged currently to the financial returns. In the balance sheet, the cost of initial provision remains fixed so long as there is no essential change in the assets.

The effective renewal costs charged to the financial returns correspond to amortisation charges on present values provided the equipment is renewed each year to the same extent as it depreciates. Here is an example: An Administration has 25 locomotives, the average useful life of which is 25 years and the actual age of them scaled from 1 to 25 years; it should replace each year one locomotive. The financial returns would be charged with a like amount whether it is charged each year with one twenty-fifth of the current value of all locomotives under the amortisation or if they carry each year the effective cost of purchasing one new locomotive as a renewal charge.

The problem of deciding if depreciation of equipment should be assessed on the prime cost or on the current cost does not arise with the « fixed value » method; evaluation is necessarily on current values.

It appears that the general method with most railways is for the annual renewal requirements to correspond to the annual reduction in value. Between the old and the new equipment is established a sort of balance in which the average age corresponds roughly to half the useful life of all the equipment. As in the example of the 25 locomotives, the depreciation corresponds to the annual need for renewal.

Often, however, because of their poor financial position, the railways cannot undertake the necessary renewals. Consequently, if the financial returns were charged only with the actual cost of renewals made, they would carry in fact, an incomplete charge. Therefore, certain Administrations replace the actual expense by a theoretical charge. These theoretical charges for renewal are calculated in principle in the same way as amortisation on current value.

At one point, however, agreement is not perfect. In the method of amortisation, a rate can be selected which takes into account future possible depreciation because of new technique. On the other hand, with a « fixed value », only actual depreciation is recorded. This is the case in particular when nothing but the actual costs of renewal are charged to the financial results. Equipment is not renewed in advance because it is necessary to reckon that, possibly because of technical development and economics, it may have to be taken out of service prematurely. In itself, the amount of the theoretical renewal to be charged to the financial results could very well include future depreciation but this would be contrary to the real idea of renewal, limited to current replacement.

If the majority of railways prefer the « fixed value » method rather than amortisation, it is not because it is more simple. The difficulties are the same with both methods when it is a case of determining the theoretical replacement costs. We say theoretical costs because when we renew an asset it is not exactly like for like. This theoretical replacement value is the basis of calculation for amortisation on current value. With the fixed value method, however, it serves to distinguish between the costs of renewal to be charged to the financial accounts or to the sinking funds, and the costs of an increase in assets. The fixed value method seems more complicated in that this delimitation must be done in each case, whilst with

the amortisation system, it is sufficient to make one annual calculation for each group of assets.

It is worth while to look for the reason for this preference in the origin of railway accounting, which was conceived in the Departmental State accountancy. This is averse to the allocation of charges which are not actually expended to amortisation. It is probable that, even to-day, the effective costs of renewal are more acceptable to State Departments than theoretical redemption.

It is true that the fixed value method has the advantage of automatically introducing the principle of current value, whilst the same principle is even partly resisted in the amortisation method.

The application of the fixed value method varies from one administration to another :

The *DB* charges the operating costs account not with the actual renewal charges, but with renewals which should have been carried out under the programme. These charges are calculated on the average useful life of different groups of assets and on the replacement cost (actual value). They thus correspond to amortisation at current value.

The *DB* calculates current value by means of a price index. The balance sheet values were re-assessed in 1949, at the time of the currency reform, and only price changes since then are taken into account.

The theoretical renewal charge is written with the operating costs and credited to a corrective account on the debtor side of the balance sheet. The same account is charged with actual renewal costs. Considered as renewal costs are costs of like-for-like replacement. When a renewal increases the productive capacity, the portion relating to increased equipment or capacity is charged to capital. For example, when steam locomotives are replaced by diesel or electric powered vehicles, the capital investment is increased only if and to the extent the new vehicles increase the capacity of the system. Strengthening of the track in renewal, for example by laying heavier rails or using more sleepers, is not considered to be an increase in assets.

We may note as a peculiarity, that the *DB* charges the operating costs with theoretical amounts, not only for renewal, but also for maintenance of equipment. Reconciliation between theoretical and actual costs is made, as for renewals, through a corrective account in the balance sheet.

The *SNCF* takes the annual maintenance and renewal costs of fixed equipment as equivalent to depreciation. Theoretical renewal charges are not formulated. The operating costs are thus made to carry the actual costs of maintenance or renewal. All work is considered as renewal or maintenance, except « new work » which increases physical assets or productivity. However, from the cost of new work is deducted a sum of 20 % representing the portion of maintenance and renewal work which is generally included. This deduction is charged to operating costs as are the costs of all new works below five million French francs and all welfare work.

For stock (vehicles, furniture and machinery) the *SNCF* charges the annual accounts, under the heading of renewal, with the cost of new acquisitions, so long as it does not exceed 9 % of the receipts from transport. Any surplus is put to increased capital investment. This percentage was obtained in 1952 by calculating the theoretical renewal charges over the useful life and the cost of replacement. By linking the theoretical charges to the transport receipts, the *SNCF* dispenses with the need to recalculate after each change of price. It is assumed that costs and receipts will follow the same price variations. During recent years, the *SNCF* has been compelled slightly to reduce its purchases in relation to renewal requirements; it has not charged the difference to operating results.

The statutes of the *FS* prescribe annual

allocations for renewal of vehicles and track steelwork (rails and fittings); these allocations are charged to the operating costs. For the other parts of the permanent way and all other classes of fixed equipment as well as furniture and machinery, the operating results are charged with the actual cost of renewal.

According to the statutes, the annual allocation for renewal of vehicles is fixed at a minimum of 2.5 % of the traffic receipts. Very often, when the need for renewal demands and the budget allows, the allocation has been increased. However, from 1948/49 till 1956/57, the minimum allocation has been reduced to 1 - 1.5 % of the traffic receipts. The new law which has been passed, will raise it to 5 % from 1957/58.

With regard to renewal of permanent way steelwork the minimum annual allocation is statutorily fixed at 0.8 % of traffic receipts in addition to the 240 L. per km. operated which has now completely lost its significance because of currency depreciation. For reasons already given, however, the actual annual allocation is greatly in excess of that called for by the above mentioned rates.

Because of the statutes, the *FS* must also redeem, by charges against the operating accounts, the loans made to finance construction and purchases.

The cost of like-for-like replacement of equipment are considered as renewal expenses. However, for certain important fixed equipment and complete vehicles, the costs of replacement are taken as an increased capital investment whilst the value of rolling stock withdrawn is taken out of capital. The principle of fixed book value is however not followed completely. The reason for this must be found in that the *FS*, being short of funds, finance these investments by appealing to the money market.

The *SNCB* has a renewal fund. Annual allocations are calculated on the useful life and replacement cost. Deficits in recent years, however, have caused these to be at a lower figure than the allocation needed theoretically. For 1956, for example, the actual payments were only 1 020 million Belgian francs, instead of 1 850 million francs.

The actual cost of renewal is covered by the renewal fund. Renewal is considered as like-for-like replacement, as on the *DB*.

In addition to allocations to renewal funds, the *SNCB*, by virtue of its statutes, must redeem its loans in 75 years by charges on the working results.

Two administrations have adopted the *amortisation method;* the *NS* and the *CFF* who use different methods of calculation:

The *NS* redeem on the basis of current value. However, for the body of the permanent way, they are content to apply the amortisation on the prime cost of purchase. The current value is obtained by price index. In practice, the *NS* first calculate the amortisation on the purchase price shown in the balance sheet; then they add to the amount thus obtained an extra one according to the price index. The extra amount is allocated to the credit of an internal renewal fund. In the published accounts, the basic sinking fund charge and the supplementary price index addition are shown as a single sum, shown under the heading of amortisation.

It may be noted that in 1938, when the Company was created, the invested capital was revalued. For all equipment purchased or built before this date, the values quoted in the first balance sheet are reckoned as the purchase price.

For fiscal reasons, the *NS* have for some time used the fixed value method for the superstructure.

The *CFF*, in principle, redeem capital assets on the purchase price. For track equipment (superstructure) and vehicles, there is a supplementary redemption, which for track equipment is calculated on the difference between the purchase price and the current value; for vehicles, only a part of the difference is used. For

vehicles, however, the supplementary redemption is only made if it does not entail a deficit.

Both administrations book renewal charges according to the rules covering the amortisation method, that is these costs are added to capital investment and consequently included in the normal redemption funds. There is thus no distinction between renewal and new investment as is the case with the fixed value method. They do not add to the capital either the costs of continuing operation during the work, or the costs of adaptation and maintenance of existing equipment carried out concurrently with construction, or any other expenses considered as non-capital cost. The *NS* add these costs to amortisation whilst the *CFF* includes them in maintenance.

3. Maintenance of assets in amount.

In showing the amounts expended by the railways in conserving their assets, it is necessary to distinguish between the accountancy charges and the actual costs. The accountancy charges include the amounts charged to the working results, under capital redemption, for actual or theoretical renewal.

The actual costs of renewal provide only an incomplete picture of the efforts made to maintain the assets unless we add the expenditures which increase the capital investment. It is true that in the narrow sense of the term, the conservation of assets includes only like-for-like replacement of equipment. However, an undertaking cannot continue to exist if it does not develop. Therefore, it should be desirable that a part at least of the means necessary for development should be furnished from auto-financing as is the general rule in industry. For railways, auto-financing is particularly indicated since a considerable portion of increased capital has no immediate effect on productivity. We need only think of the large amounts spent to increase safety operation ! It would not be possible to disregard increased capital because it is difficult in practice to find a line of demarcation between like for like replacement and increased value. The administrations which use amortisation do not reckon with this difference in their accounts.

Finally, to make comparisons between the different administrations, it is necessary to compare the actual figures with the statistical details.

a) *Accounting charges for maintenance of assets.*

Taking an average of the years 1951/55, working results were debited with the amounts shown on Table 1 for maintenance, redemption or renewal of assets.

The administrations have made the following observations on this table :

The *SNCF* figures are an average of the years 1954 and 1955 as the system described earlier dates only from 1952 and was fully operative only from 1954.

The *FS* figures shown under redemption or renewal cover the annual amounts allocated to the various renewal funds, the annual allotment for improving and increasing equipment, as well as the charges resulting from financial amortisation of cash loans which have been contracted to finance construction and renewal.

On the *SNCB*, the costs of vehicle maintenance are lower than the normal costs because of the introduction, during the years covered, of a fairly large number of new locomotives and motor coaches for diesel or electric operation, the maintenance costs of these being still low. The renewal charge is below the calculated theoretical charge because, as we have already said, the *SNCB*, — because of the financial position — has been only able to allocate to the renewal funds 1 020 million Belgian francs, instead of 1 850 millions considered necessary.

The *CFF* amortisations include the usual type of sinking fund. The unusual sinking funds based on the excess of receipts and intended to overcome the delay due to insufficient redemption in the past, have not been included.

TABLE 1.

ACCOUNTING CHARGES FOR MAINTENANCE OF ASSETS, IN AVERAGE FOR THE YEARS 1951-1955 (M = MILLION)

	DB		*SNCF*		*FS*		*SNCB*		*NS*		*CFF*	
	M. DM.	%	M. French fr.	%	M. It. lire	%	M. Belg. fr.	%	M. Dutch fl.	%	M. Sw. fr.	%
a) *Maintenance :*												
Fixed equipment . .	717.5	51.7	56 431	36.6	40 760	55.4	672.5	38.3	38.4	52.3	87.4	57.5
Vehicles	669.4	48.3	97 560	63.4	32 813	44.6	1 084.2	61.7	35.0	47.7	64.6	42.5
Total	1 386.9	100	153 991	100	73 573	100	1 756.7	100	73.4	100	152.0	100
b) *Redemption or renewal :*												
Fixed equipment . .	451.3	60.3	51 625	59.0	11 366	76.2	590.6	56.5	59.5	67.1	59.9	56.8
Vehicles	296.7	39.7	35 872	41.0	3 546	23.8	455.1	43.5	29.2	32.9	45.6	43.2
Total	748.0	100	87 497	100	14 912	100	1 045.7	100	88.7	100	105.5	100
c) *Total* a) *and* b) *:*												
Fixed equipment . .	1 168.8	54.7	108 056	44.7	52 126	58.9	1 263.1	45.1	97.9	60.4	147.3	57.2
Vehicles	966.1	45.3	133 432	55.3	36 359	41.1	1 539.3	54.9	64.2	39.6	110.2	42.8
Grand total	2 134.9	100	241 488	100	88 485	100	2 802.4	100	162.1	100	257.5	100
d) *Total :*												
a) Maintenance . . .	1 386.9	65.0	153 991	63.8	73 573	83.1	1 756.7	62.7	73.4	45.3	152.0	59.0
b) Redemption . . .	748.0	35.0	87 497	36.2	14 912	16.9	1 045.7	37.3	88.7	54.7	105.5	41.0
Grand total	2 134.9	100	241 488	100	88 485	100	2 802.4	100	162.1	100	257.5	100

As percentages of *total charges* and *traffic receipts,* the accounting charges for maintenance of assets (maintenance, redemption and renewal charges combined) are as follows :

TABLE 2.

	Total charges %	*Traffic receipts* %
DB	39.2	44.0
SNCF	39.7	55.5
FS	32.8	45.3
SNCB	23.5	26.5
NS	43.0	42.9
CFF	35.4	36.7

The comparative value of these figures is reduced by the fact that « political » charges included in the total charges vary from one administration to another (abnormally high pensions, employment of supernumerary personnel, etc.). As mentioned further on, the capital expenditure also shows important variations. Traffic receipts depend on the level of charges of the different administrations.

It is also possible to relate the accounting charges for maintenance of assets to the *length of lines operated* and to the *traffic statistics.* To allow easier comparison, we have calculated the values in gold francs. (See Table 3.)

The charges per kilometre operated are high on the *CFF* owing to the geographical conditions and to the widespread electrification which has been undertaken, entailing large expenditures on fixed installations.

The amount of use of the equipment affects the cost of the working units. The greater is this amount, the lower are the proportionate costs per working unit, and vice versa.

To judge the charges to be made for maintenance of assets, there is no doubt that the *value of the invested capital* is the most appropriate standard for comparison. The balance sheet value must be disregarded at once, because it differs according to the accounting method used. Only the current replacement value can be taken into consideration, even though it may only be a summary estimation.

As the replacement value given by the administrations relates to the 1955 results and that on various railways this value has been considerably changed during earlier years, it is not the average charges from 1951-1955, which are compared above, but the charges for the year 1955 only (Table 4).

TABLE 3.

	Accounting charges for maintenance of assets		
	per km operated in gold francs	per train/km in gold francs	per 1 000 gross tons/km hauled in gold francs
DB	51 072	2.96	8.66
SNCF	53 091	5.48	12.04
FS	26 110	2.07	6.74
SNCB	34 636	2.32	6.35
NS	40 926	2.03	.
CFF	61 942	2.68	9.87

TABLE 4.

	Charges for maintenance of assets as percentage of replacement value of fixed assets		
	Fixed installations %	Vehicles %	Total %
Maintenance :			
DB	2.4	6.0	3.3
SNCF	1.4	5.7	2.6
FS	1.9	3.0	2.3
SNCB	1.4	2.3	1.9
NS	2.1	3.9	2.7
CFF	1.9	3.1	2.3
Redemption or renewal :			
DB	1.6	3.0	2.0
SNCF	1.2	2.1	1.5
FS	0.6	0.5	0.6
SNCB	1.3	1.0	1.1
NS	2.9	3.0	3.0
CFF	1.3	2.2	1.5
Total maintenance, redemption or renewal :			
DB	4.0	9.0	5.3
SNCF	2.6	7.8	4.1
FS	2.5	3.5	2.9
SNCB	2.7	3.3	3.0
NS	5.0	6.9	5.7
CFF	3.2	5.3	3.8

Finally, as far as the administrations have used them, we show in the following Table 5, p. 372/12, the most important *rates of redemption or renewal.* The percentages are based on the useful life and probable residual value.

These percentages are not immediately comparable. It is necessary particularly to note the way in which the administrations make their maintenance and renewal policy and charge the cost. For example, the low rate applied by the *CFF* for amortisation of ballast is explained in the official financial report of the Swiss Railways which charges ballast to track foundation. To cover insufficient amortisation, the cost of ballast renewal is charged to operating account. The *NS* which applies a redemption charge for the ballast at the rate of 2 % also charges all renewals of it to the operation account.

We may recall also that the *DB* allocate maintenance to working results by means of fixed rates, which include probably a part of the expenditure otherwise covered by redemption or renewal charges.

b) *Expenditures actually incurred in maintenance of assets and increases in fixed assets.*

The average annual expenditures actually incurred in renewals or increased fixed assets over the years 1951-1955 are shown on page 373/13 (Table 6).

TABLE 5.

RATES FOR REDEMPTION OR RENEWAL

	DB	*SNCB*	*NS*	*CFF*
	%	%	%	%
Railway installations :				
Land	—	—	—	—
Foundations, etc. :				
Body of the permanent way including tunnels	0.153-0.553	—	1.5	1.0
Structures, bridges, etc.	1.124-1.166	(1)	1.0-2.0	1.5
Permanent way :				
Ballast	3.0	2.3	2.0	1.0
Sleepers, rails, switches	3.0	1.6-4.6	4.0	3.0
Buildings and fixed installations of the stations :				
Buildings	1.1	(1)	1.33-3.0	1.0-2.0
Fixed station equipment		3.5	4.0-6.0	3.0
Contact line installations	1.899	1.6-3.2	2.5-4.0	2.5-3.0
Telecommunications and safety equipment	1.901-1.906	3.2-3.8	4.0	4.0
Machines, furnitures and tools	(2)	3.8	100.0	5.0
Rolling stock :				
Motive units :				
Steam locomotives	2.550	1.9-2.4	3.5	4.0
Electric locomotives	3.333	2.1	3.5	4.0
Diesel locomotives, motor coaches, railcars, etc.	4.0 (railcars = 10.0)	2.1-3.8 (railcar engines = 6.5)	3.5-4.0 (int. combustion engine = 10.0)	4.0
Coaches	2.5	1.9	3.5	4.0
Freight wagons	2.760	1.7-2.1	3.0	2.5

(1) Contractual amounts corresponding approximately to actual annual expenditures on renewals.
(2) Redemption is included in the classes where material is used or to which material is allocated.

In the *SNCB* figures purchase of vehicles financed by recovery of war damages is omitted. On the other hand, if the expenditures devoted to fixed equipment are particularly high, this must be attributed to the extensive work undertaken to electrify the main lines of the system.

The actual expenditures incurred in

TABLE 6.

EXPENDITURES ACTUALLY INCURRED IN MAINTENANCE OF ASSETS AND INCREASES IN FIXED ASSETS, IN AVERAGE FOR THE YEARS 1951-1955 *(M = MILLIONS)*

	DB		*SNCF* (1)		*FS*		*SNCB*		*NS*		*CFF*	
	M. DM.	%	M.French fr.	%	M. It. l.	%	M. Belg. fr.	%	M. Dutch fl.	%	M. Sw. fr.	%
a) *Renewals :*												
Fixed installations . .	280.8	62.6	46 633	56.5	.		1 164.6	76.6	.		.	
Vehicles	167.8	37.4	35 872	43.5	.		355.0	23.4	.		.	
Total	448.6	100	82 505	100	.		1 519.6	100	.		.	
b) *Increased fixed assets:*												
Fixed installations. .	249.6	59.9	40 907	94.7	.		744.0	95.5	.		.	
Vehicles	167.5	40.1	2 295	5.3	.		34.8	4.5	.		.	
Total	417.1	100	43 202	100	.		778.8	100	.		.	
c) *Totals of* a) *and* b) *:*												
Fixed installations. .	530.4	61.3	87 540	69.6	30 297	63.0	1 908.6	83.0	77.1	49.5	92.4	66.3
Vehicles	335.3	38.7	38 167	30.4	17 757	37.0	389.8	17.0	78.7	50.5	46.9	33.7
Grand total	865.7	100	125 707	100	48 054	100	2 298.4	100	155.8	100	139.3	100

(1) Average of the years 1954-1955.

renewals and increased capital equipment, as a percentage of the replacement value, were as follows :

TABLE 7.

	Equipment %	*Vehicles* %	*Total* %
DB	1.7	3.0	2.1
SNCF . . .	2.1	2.2	2.1
FS	1.3	1.4	1.3
SNCB . . .	4.1	0.9	2.5
NS	3.4	6.8	4.6
CFF . . .	1.9	2.2	2.0

c) *Financing of renewals and increased capital equipment.*

The fact of accounting amortisation or the total of theoretical renewal — even roughly calculated — to the account of working results does not signify an assurance that the financial resources necessary for renewal are available. This is only the case when these charges have counterparts in receipts or when the State makes good the deficit. Otherwise, it is not possible to renew the equipment or then it is necessary to call for outside capital. This method is, however, unhealthy. The two latter cases are, however, found in several of the administrations considered between 1951 and 1955. A fortiori, the resources necessary for investment have not been available.

The *DB*, because of lack of resources, was forced to reduce considerably its programme of maintenance and renewal. In general, the accounts showed a deficit and as the State did not cover this, the deficits had to be carried forward.

In fact, increased capital equipment was entirely financed by outside capital (borrowing, Treasury bonds, bankers' loans, etc.).

The *SNCF* accounts are also closed with deficits, but the State has taken them over. Thus the *SNCF* has been able to undertake maintenance and renewal considered necessary and has found ways of financing them without outside capital. However, for vehicles, the actual expenditure for renewal has not reached 9 % of the traffic receipts.

Of the actual increases in assets, 12 % have been charged in advance to the operating account as a quota of renewal and maintenance carried out in relation to new work. These charges have thus been financed from their own resources or by the State covering the deficit. Twenty-eight per cent have been paid by the State or other groups as compensation for war damages or subsidy. The remainder 60 %, have had to be obtained by loans from the State or other loans and bank credits.

On the *FS*, too, deficits are made good by the State. However, the magnitude of these deficits has compelled the *FS* to reduce the programme of maintenance and renewal, and even to undertake borrowing to finance a part of it. Fifty-seven per cent of the amounts allocated to increased capital investment are covered by subventions from the State, of which 47 % are as compensation for war damages; the remaining 43 % being obtained mainly by loans.

The *SNCB*, on the whole, has also shown a deficit, but has not benefited from sufficient State assistance to cover same completely. Therefore, allocation to renewal funds and actual renewal expenditure has had to be reduced accordingly. In accordance with its statutes, all increased capital investment has been financed by loans.

The *NS* and *CFF* have not had deficits and have not been prevented from operating amortisation and carrying out their programmes of works without restriction; whereas on the *CFF*, however, other factors have come into play. These two railways cannot separate the financing of renewals from increases of their assets.

The *NS* have been able to finance 75 % of their investments from their own resources (sinking funds and reserves); they have financed the remaining 25 % by increase in capital liability. In this respect, it may be recalled that for the period considered and in relation to the replacement value of all fixed assets, the *NS* have invested more than double the amount that the other railways have.

With regard to the *CFF*, not only have they been able to finance from their own resources the expenditures on renewal and additional capital investment, but have also repaid loans of nearly 167 million francs. That was possible, firstly because of the extraordinary amortisation of about 160 million francs provided from surplus receipts, and secondly, because the *CFF* were compelled to limit their programme of work owing to political reasons forced upon them by the too-high general activity level in constructional works. During the next few years, it will be necessary to finance the increase of fixed assets by means of outside capital.

Most railways consider that in future the need for capital will increase because they will have to develop their equipment to meet the requirements of modern traffic and technical progress. They have compiled five and ten-year programmes which forecast, for renewal and extension, an annual expenditure of up to 5 % of the replacement value. They do not yet know, however, how they will be financed. In any case, they will have to finance the development of installations beyond simple renewal by outside capital unless the State intervenes. Generally, it must be expected to see the part of outside capital increases and on the same basis, the capital costs too.

The relative reduction of cost of capital over the last few decades seems to be replaced by an increase. The following figures (1955) show how low the cost of capital is in relation to total charges.

	Cost of capital as percentage of total charges for 1955 %
DB	1.8
SNCF	2.7
FS	3.6
SNCB	3.3
NS	1.1 (1)
CFF	6.2 (2)

(1) 3.1 % if account is taken of dividends paid on shares and deducted from the profit.

(2) 8.1 % if account is taken of dividends paid on State-provided capital and deducted from the profit.

The charges of providing capital are understood without the legal or statutory financial sinking funds. In this report, these financial sinking funds have been added to the normal industrial amortisations because the former serve only to complete the latter, which are considered inadequate.

If the capital charges of the *CFF* are heavier than those of all other systems, this must be attributed in the first place to the very high construction cost, due to the topographical conditions of the country. In addition, as currency depreciation is far less in Switzerland, the debt has been lightened only slightly. Finally, if the charges on capital of certain administrations are lower, the reason is that the State has given them free use of equipment at the time of their establishment and after the last war has made itself responsible for a large part of the cost of reconstruction.

Lastly, the very low charges on capital on the *NS* reflects the favourable structure of their capital assets, i.e. the preponderance of their own capital.

III. CONCLUSIONS.

Because of the constant depreciation of money which has been experienced to a varying degree by all countries, the prob-

lem of conserving assets is more vital than the simple conservation of nominal capital. For undertakings with a heavy capital investment, as railways have, the problem is of particular importance.

The classical form of redemption, by which the original cost is spread over the useful life of the equipment, becomes inadequate when money loses its value.

To retain the substance, which is essential for the existence of an undertaking, it is necessary to adjust sinking funds to the current value of the fixed assets.

Industry adopts this principle in a general way, although it is not always in the form of amortisation on current value; in practice, use is made of a very high sinking fund rate, proceeds to accelerated amortisations during the early years of usage, charges immediately to profit and loss the expenditure which forms an increase in value, or, finally, establishes a reserve. In general, auto-financing is not limited to maintenance of assets, it also includes a large proportion of increases in capacity.

The railway administrations consulted are also of the opinion that the purchase price is not a suitable basis for calculating amortisation. Only the *NS* officially uses amortisation on current value. The other administrations, instead of redemption, charge the working results with theoretical charges or actual costs of renewal. Theoretical renewal charges are based on current value; actual renewal costs are automatically on this basis. Only the *DB* materially charges the working account with theoretical renewal amounts whatever the balance, and this administration uses a system which is equivalent to amortisation on current value. On the other administrations, over the period considered, the charge to operating account has been more or less influenced by the resulting credit or debit balance, although less on the *SNCF* than on the *FS* and *SNCB*.

Moreover, on these railways, the charges for maintenance of assets included in the working results are, in relation to the actual value of the fixed assets, less that on the *NS* and *DB*. Because the distinction in accountancy between the costs of maintenance, redemption and renewal varies from one administration to another, it is desirable to consider the charges in total.

The *CFF* is the only administration to use amortisation on initial cost. However, for the permanent way and vehicles, they complete this by an additional sinking fund, which allows at least partial compensation for the increase of the cost of replacement. In addition, on the *CFF* the amortisation rates are in part greater than those of the other administrations. As a percentage of the replacement value, the debit of the results account is lower than on the *NS*, the *DB* and the *SNCF*, but higher than on the *FS* and *SNCB*.

The two methods — fixed value and amortisation — can be considered as identical in their effects. Both permit the real depreciation of equipment to be taken into account.

However, the reporter sees an advantage in the amortisation method. It is simpler and above all can be understood by non-specialists because it confirms to general commercial practice.

Even by making adequate sinking fund allowances, there is still no assurance of conserving of assets. It is still necessary to have corresponding receipts. But, during the period under consideration, this was so only on the *NS* and *CFF*. In general, the accounts of the other administrations showed deficits. As the State did not wholly or partially cover their deficits, the *DB* and *SNCB* were compelled from lack of resources to reduce their maintenance and renewal programmes. Whilst on the *SNCF* and *FS* the deficits have been covered by the State, they have none the less adversely affected the carrying out of their renewals and extensions, especially on the *FS*.

Compared with those of industry, the

charges for amortisation and renewal on most railways are too low. This proves more than the fact that these administrations are behind with the renewal and modernisation of their equipment. It is not that the railways have a worse method of accounting, but that receipts are not sufficient.

Whilst certain railways might be criticized regarding the official presentation of their accounts, it is because the latter do not shown the charges for amortisation and renewal as fully as actual depreciation calls for. This criticism in fact concerns, however, not so much the railway administration but the State, as it is the latter which puts a restriction in this respect.

The fact that the railways do not adequately redeem capital, because receipts are insufficient, can only have grave consequences. Insufficient amortisation prevents punctual replacement and modernisation of assets. In turn, excessive age of equipment and vehicles weakens the ability of the railways to face their competitors; this is an obstacle to their rationalisation. Their financial position thus continues to worsen and the possibility of setting up sufficient amortisation diminishes. Finally, installations and vehicles become obsolete, deficits become chronic, and some means to render the enterprise wholesome becomes necessary. The railways can escape this vicious circle only if they are allowed to amortise to the same extent as industry and to create reserves in favourable years; that is, they must live by their own resources. It is better that railways should live by their own resources rather than receive public aid; but in order that railways may continue to exist from their own resources they must be released of the unjustifiable political charges and obligations in relation to industrial economy, and be allowed to achieve a reasonable co-ordination of transportation.

[625 .143]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 2.

Very long rails. Welding methods. Transport of long welded rails and necessary equipment for transporting, laying, fixing, ballast, tamping, etc.

Economic aspect of the question. Present tendencies.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, Union of Soviet Socialist Republics and the United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by F. JACKSON,

Assistant Chief Civil Engineer (Maintenance), South African Railways and Harbours, Johannesburg.

Nine replies were received to the questionnaire submitted to 33 Managements. In addition, however, the Association of American Railroads submitted valuable information which had been collated by their « Special Committee on Continuous Welded Rail » from 15 railways on the North American Continent. Of the Managements who had replied four have had little experience in the use of long welded rails and the report is confined to those countries which have had adequate practical experience.

On three of the railways the gauge is 3'6" on the other 4'8 1/2" or broader. There is no very material difference in practice due to the difference in gauge.

1. Definition of long rails and statistical information.

Question 1.1. — *After what length does your Administration make use of the expression « long welded rails » (L.W.R.) seeing that by this we mean a rail the central part of which never undergoes any movement as a result of temperature variations?*

Answer : Replies varied from 91.4 meters to 213.3 meters. A reasonable standard to adopt appears to be 100 meters or longer.

Question 1.2. — *Please show in table form the general information collected about L.W.R. used on main lines.*

Answer : See Table 1.

(a) *Overall lengths of the principal sections laid with L.W.R.?*

Answer : In most countries the use of long rails is largely experimental and no definite policy has been reached with regard to the length of section to be laid with long rails.

(b) *Total cumulative length of the sections so laid compared with the total length of main lines on your system?*

Answer : The greatest total length of L.W.Rs. is found on the American Continent where 1 152 km have been laid.

(c) *Maximum speed allowed over the L.W.R.?*

Answer : In general the maximum speed is the same speed as is permitted on lines with normal length rails.

(d) *Gross daily tonnage on the most important sections?*

Answer : The gross tonnage indicates that L.W.Rs. are being used on some of the busiest lines in the countries concerned.

(e) *Maximum temperature variations : Annual and daily in regions where the L.W.Rs. are assembled? (The temperatures are taken as measured in the rail-head).*

Answer : Annual variations in temperature varied from 60° C to 90° C and the daily variations 21° C-42 °C.

(f) *Kind of sleepers — wood, steel or concrete; number per km?*

Answer : L.W.Rs. are used on wood, steel and concrete sleepers. Numbers varying from 1 240 to 1 920 per km.

(g) *Method of fastening the rails to the sleepers?*

Answer : Dog spikes, elastic spikes, clips and bolts, cast irons chairs with keys are all used.

(h) *Kind of ballast?*

Answer : Crushed stone.

(i) *Methods of welding used?*

Answer : Electric arc, thermit, oxy-acetylene, and flash-butt have all been used, but preference now seems to be for flash-butt.

(j) *Are expansion devices used or not?*

Answer : Generally no special joints are used for expansion although where the rail is not rigidly held to the sleeper, rail anchors are used to prevent expansion. In some cases, special splice joints which allow for expansion are being used.

(k) *Year when L.W.R. were first introduced?*

Answer : Earliest L.W.Rs. used in 1936, but originally only experimentally in tunnels.

(l) *Quantity of ballast per kilometre of track?*

Answer : 1 250-2 250 cub.m/km.

(m) *Type of joints at ends of L.W.R.?*

Answer : Generally standard suspended joint with normal fishplate, but in some cases special splice joints. In other cases L.W.Rs. are separated by three ordinary length rails.

(n) *Are rubber pads used between rail seat and sleeper, spleeper chair and sleeper or rail seat and sleeper chair?*

Answer : Rubber pads are only used when concrete sleepers are used and are inserted between rail seat and sleeper.

2. Usefulness of using long welded rails.

Question 2.1. — *In order to obtain both better running and a decrease in maintenance costs, does your Administration consider that the best solution is to use L.W.R., or on the contrary, have you*

found by experience other equally satisfactory solutions? In the latter case, please give details of such solutions and the results obtained (see also question 5.4).

Answer : With one exception L.W.Rs. are considered to be the solution. One railway considers a medium length welded rail to be a better solution than the L.W.R.

Question 2.2. — *Have you found that there is any improvement, however small, in undulatory wear on sections laid with L.W.R.?*

Answer : In no case has any opinion been expressed.

3. Manufacture of long welded rails.

Question 3.1. — *What method of welding does your Administration use to make L.W.R.?*

With which method have you obtained the best results?

In carrying out such welding, have you any technical specification, especially as regards recording certain methods of detecting defects?

Answer : The most favoured method of manufacturing L.W.Rs. is by flash-butt in depot into transportable lengths and thermit welding into L.W.Rs. on site.

Gas welding is, however, also used very successfully. Generally no technical specification is laid down, but in some cases the « tup » test is used and in other cases ultrasonic detectors.

Question 3.2. — *If the method of welding used involves adding steel, what differences are there between the steel used for the rails and this added steel, the object in view being to avoid the production of hollow surfaces or bumps on the running surface near the welds after a certain time?*

If the method of welding used does not involve the addition of steel, have you found that there are any changes in structure in the welded zone likely to give rise to the same type of defect? If so, have you found any way of preventing this?

Answer : Where steel is added as in thermit and gas welding it is of such a composition as to ensure that it is as near as possible in composition to the steel in the parent metal. In case of flash-butt welding nothing is added and generally the welded area is slightly harder than the parent metal.

Question 3.3. — *Whatever kind of welding is used, do you consider that it is useful, or at least advisable, to heat-treat, anneal or normalise the welds?*

Answer : Thermit welds are not heat-treated. Gas pressure welds are annealed and both preheating and postheating has been carried out in the case of electric arc welding. 7 railways use the flash-butt process. Of these 4 anneal and 3 do not anneal. It appears from latest tests that heat treatment of flash-butt welded joints is perhaps unnecessary.

Question 3.4. — *In order to prevent noise arising at welded joints similar to — though on a much reduced scale — that produced at fishplated joints, do you enforce any precise regulations concerning the tolerances allowed in lining up both in level and on the cross section, the welded joint being rejected where such tolerances are exceeded?*

Answer : Straight edges of varying lengths are used to ensure that the running surfaces are true.

Question 3.5. — *What is your opinion concerning the most suitable length for L.W.R. from the technical, economic and practical points of view?*

In order to arrive at this length, have you taken as a basis theoretical considerations or only practical considerations?

In the first case, please give the hypotheses used, the maximum temperature

variations allowed for, and the form of calculation used.

Answer : Theoretical considerations do not place any limit on the length of the L.W.R. provided curves, grades, roadbeds, etc., place no restrictions on their use.

Practical considerations limit the length of shop welded rails (such as space available at the welding depot, maximum permissible length of train).

Lengths vary from approximately 40 m to 500 m. There is no definite conclusion as to the ultimate most practical length of L.W.Rs., but most railways appear to favour a length of approximately 800 m.

Question 3.6. — *What is the smallest radius of curve on which you consider it is possible to use L.W.R.?*

Is this limit determined by theoretical studies, or prudence, or have you learnt by experience what limits must not be exceeded?

Answer : In practice rails are being laid on curves as sharp as 400 m radius on 4'8 1/2" and 800 m on 3'6" gauge. Experiments and calculations have shown that L.W.Rs. can be laid on sharper curves provided the roadbed is very well consolidated. Prudence has dictated restriction to the flatter radius until more experience has been gained.

Question 3.7. — *If there are many straight lengths on a section of a line suitable for L.W.R. and at the same time curves whose radius is below the admissible limit mentioned under point 3.6 above, what is the maximum length of rails used by you?*

In such a case do you consider it better to lay the rails with the joints staggered rather than opposite each other?

Answer : Very little information has been provided in answer to this question due chiefly to the fact that the use of L.W.Rs. is not general and they are being laid first where they can be used without restrictions due to curvature. In all cases square joints are preferred.

Question 3.8. — *Do you consider it necessary to use expansion devices at the ends of L.W.R., enabling the ends to move to a certain extent? If so, have you found that after a certain time in service these had to be re-set owing to abnormal internal stresses developed in some central portion of the rail? If so, what do you do?*

If on the contrary you do not consider it necessary to use an expansion device at the ends of L.W.R. allowing the normal joint gap to be exceeded — about 20 mm — has practical experience confirmed you in this opinion or have any disadvantages been experienced with these rails so that in the future you will use expansion devices able to allow more movement?

Answer : The largest number of L.W.Rs. is used on the North American Continent and no expansion devices are used, but the number of rail anchors is increased at the ends of the L.W.R. Other railways are using expansion devices, but there is still insufficient information to justify their use. Experience in the U.S.A. seems to indicate that an expansion joint is unnecessary provided the stress in the rail is adequately held by using sufficient rail anchors and sufficient sleepers at the ends of the rails. Where expansion joints are used the L.W.R. is destressed once per year by loosening and refastening all fastenings when the temperature is within the proximity of 20° C.

Question 3.9. — *What type of expansion device is used on your railway? Please supply drawing.*

What is the cost of this device compared with the length of track it takes up?

What expansion limits have you adopted?

What is the effect of the cost of expansion devices on the cost of a kilometre of running line?

Same question in the case that you do not use expansion devices but make use of certain special devices — anticreep

devices for example — with your L.W.Rs. Please attach drawing of joints and special devices.

Answer : Only four railways reported the use of expansion joints as a general rule and costs vary from about £50 to £400, the latter for a special joint developed for two way traffic on a single line.

The maximum movement permitted by expansion joints is approximately 125 mm. The cost of the most expensive joint adds 6 % to the cost of the track and is not considered to affect a decision with regard to use of L.W.Rs.

Where expansion devices are not used, rail anchors are used, but the cost of these is negligible compared with the cost of the welded track.

See Annexure No. 1 for drawings of expansion joints and rail anchors.

4. Laying long welded rails.

Question 4.1. — *Amongst the types of sleepers used — wood, metal, concrete — which do you consider most suitable for use with L.W.R.?*

Do you use the same sleeper spacing — number of sleepers per km — with L.W.R. and standard length rails (15 to 36 m)?

Have you found any considerable difference in the behaviour of L.W.R. laid on wood, metal or concrete sleepers?

As regard the resistance of the track to transverse displacement, are not metal or concrete sleepers better than wood sleepers?

Answer : Where concrete sleepers have been tried they are preferred to other types as the greater weight increases resistance to buckling of the track. Wood and steel sleepers are, however, being used without trouble.

Generally the sleeper spacing for L.W.Rs. is the same as that for conventional rails.

In practice no difference has as yet been detected in behaviour of different types of sleepers, but tests have indicated greater resistance to buckling where concrete sleepers are used.

Tests have shown that steel and concrete are more resistant to buckling than wood, but in practice the factor of safety used is sufficient to render any type safe on a well consolidated roadbed.

Question 4.2. — *How do you fasten the L.W.R. to the sleepers? Please attach drawings.*

In general amongst the methods of fastening used in the case of standard length rails — 15 to 36 m — which methods are equally suitable for use with L.W.R. and which must be avoided?

Have you used elastic spikes to fasten your long rails, and if so, with what results?

Do you consider that anticreep devices should be used with L.W.R. when the fastenings do not keep the rail firmly anchored to the sleeper :

(a) *With expansion devices;*

(b) *Without expansion devices?*

Answer : No special device is used for fastening L.W.Rs. to sleepers. Generally with concrete sleepers an elastic clip is used. All standard methods of fastening standard length rails to sleepers are in use in the case of L.W.Rs., with the addition that anti-creep devices are used where movement between the rail and the sleeper is possible.

Elastic spikes type A-6 per sleeper have been used satisfactorily in a test by one railway.

With L.W.Rs., in all cases where the rail is not anchored firmly to the sleeper, anti-creep devices are used, irrespective of whether expansion joints are used.

Question 4.3. — *To increase the transverse resistance of the track especially on curves — have you considered it advisable to widen the foundation of the permanent way on the outside of the track? Up to what limits can such a widening be considered effective? Please attach*

drawings of ballast section, normal and special for L.W.Rs. in straight track and on curves.

Answer : Due to the introduction of long rails three out of fifteen railways in the North American Continent have increased the width of shoulder ballast from 125 mm to 254 mm. Railways, other than North American, consider that the width of shoulder should be 400-450 mm, but that no advantage is to be obtained by increasing it to more than 450 mm. American Railways generally have larger sleepers and more per kilometre and their track is, therefore, more resistant to buckling than others.

No distinction is drawn between straights and curves.

See Annexure No. 2 for ballast diagrams.

Question 4.4. — *When laying track with L.W.Rs. which one of the following methods do you consider best from the point of view of transport to the site :*

(a) *Long rails welded in the shops up to lengths of 100 m or more?*

(b) *15 to 36 m long rails?*

(c) *15 to 36 m long sections assembled complete beforehand?*

Is your choice of method (a), (b) *or* (c) *above based on the speed and facility of laying in this case, or is it based solely on economic considerations?*

If you know the cost of the three methods of laying given above — or of equivalent methods — please give us details of the results obtained?

Answer : Railways of the North American Continent, which have most experience in the use of long rails, do not favour the use of field welds. Rails are shop welded into final lengths of approximately 450 m. Other railways are still experimenting with long shop welded rails and a few field welds or short shop welded with a large number of field joints. The British Railways are experimenting with prefabricated track field welded.

The use of mobile depots, with consequent reduction in distances L.W.Rs. have to be transported, will probably affect the method eventually adopted.

The adoption of L.W.Rs. welded in shops by the American Railways is influenced by the fact that renewals of rails and sleepers are not normally carried out at the same time and the shop welds are more reliable than the field welds.

Question 4.5. — *Once the maximum temperature variations in localities, where L.W.R. are laid, are known, how to you decide the temperature at which such rails are to be laid, i.e. the temperature to be used as a basis for setting up the joints in the expansion devices, or at which the final welds will be carried out if there is no joints left?*

Do you heat the rails in order to get by artificial means the required temperature for correct laying? If so, how and with what success?

If the long rails are made up from 15 to 36 m long rails, in what order are the welds made so as to keep the stresses as low as possible?

Answer : Generally the final fastening down of L.W.Rs. is done at approximately the mean of the annual maximum variation temperatures for the area concerned.

The heating of rails by artificial means has not been tried out.

Where short rails have been welded in the field, it is the practice to weld them consecutively.

Question 4.6. — *Are the sleepers carrying the L.W.R. laid directly on the normal type of ballast or on an intermediate layer of fine gravel some centimetres thick?*

In which case does the stabilization of the track occur the quickest?

Answer : In all cases sleepers are laid directly on ballast.

Question 4.7. — *Is the present tendency to reduce the amount of ballast used, leaving the spaces between the sleepers almost without ballast, advisable in the case of L.W.R.? Does not this affect the lateral strength of the track?*

Answer : Ballast should be kept up to the top of the sleeper to increase ballast resistance to movement of sleeper.

Question 4.8. — *Is any speed restriction imposed on track in which L.W.R. have been newly laid and, if so, what is it and for how long its duration?*

Answer : Speed restrictions are not imposed on account of L.W.Rs. The speed restrictions imposed for trackwork with normal length rails are also imposed under similar conditions in the case of L.W.Rs.

5. Maintenance of lines laid with long rails.

Question 5.1. — *In view of the fact that the maintenance of lines laid with L.W.R. differs considerably from that of lines laid in the classic fashion, has your Administration prepared any technical notes regarding the special maintenance of such track?*

If so, please give an example and stress the most striking points?

Answer : The railways are almost unanimous in requiring that no loosening of fastenings, lifting of track or opening out of the ballast should be done unless temperatures approximate the temperatures at which the L.W.Rs. were originally fastened down.

The range of temperature during which these operations are permitted is approximately 13°-23° C.

Question 5.2. — *Are defects in level occurring in service corrected by means of mechanical tamping or shovel packing? What advantages and what drawbacks have you found in these two methods?*

Answer : Defects in level are being corrected by both mechanical packing and shovel packing. Mechanical packing is preferred as shovel packing reduces the lateral resistance of the track.

Question 5.3. — *What is the approximate duration of the period of stabilisation of long rails? During this period what is the number of platelayers-hours per km required for correct maintenance?*

Once the period of stabilisation is over, how many platelayer-hours are required per km per annum?

Answer : Replies to the first part of this question are inconclusive. Where the L.W.Rs. are laid on sleepers already stabilised, as in the U.S.A., there is no period of stabilisation. Only one railway gave a figure for maintenance of L.W.R. track as required, the figure being 600 platelayer-hours per kilometre per annum where traffic amounted to 26 000 000 tons annually. The American Railways estimate a saving of 25 % in maintenance. London Transport Executive report a reduction of 170 man-hours per kilometre per annum for nearly the same traffic.

Question 5.4. — *From your experience of the life of the component parts of track laid with L.W.R., the maintenance costs in question being known, can you give any comparison between the cost of the classic type of track and that of track laid with L.W.R., all the various factors which come into play being taken into account.*

Answer : Only the American Railway Engineering Association and the Japanese National Railways have attempted to assess the monetary saving arising from the use of L.W.Rs.

The American Railway Engineering Association give an annual average figure of approximately 600 dollars per kilometre for savings due to (*a*) lower maintenance costs, (*b*) longer life of rail (estimated to be 29 years as against previous 22 years), (*c*) extension of complete repacking cycle from 5.1 years to 7.5 years.

The Japanese figures of estimated cost per annum per kilometre given in yen are :

(a) L.W.R. welded in depot .	1,578,410
(b) L.W.R. field welded . .	1 558 090
(c) Standard rails	1 600 760

These figures take into consideration saving in maintenance, but not any longer life from L.W.Rs. compared with standard rails.

Question 5.5. — *What incidents have occurred on sections of your system laid with L.W.R.?*

Please give a description of the most characteristic incidents and explain all the circumstances fully.

What steps have you taken to deal with fractures of L.W.R.?

Answer : One railway reports 55 breaks out of 7 500 gas welds. Otherwise, no incidents due to the use of L.WRs. as against standard length rails. Fractures are dealt with initially by clamping fishplates on break and later when temperatures are favourable cutting out broken portion of rail and welding suitable replacement in its place.

Question 5.6. — *What special restrictions — if any — are imposed on ordinary maintenance work on L.W.R. sections such as packing sleepers, cleaning ballast and any other works that would disturb the stability of ballast.*

Answer : Any operation that will disturb the stability of the track must not be carried out at excessively hot or cold temperatures, but in the vicinity of 20° C.

One railway has submitted a complete table showing restrictions on various operations. This table is appended *(Table No. 2)*.

Summary.

A careful study of the replies very kindly submitted reveals an enthusiasm for the use of L.W.Rs., but little application beyond the experimental stage except in the case of the North American Continent where 1 152 km are already in use.

L.W.Rs. have been successfully used without speed restrictions where the annual temperature varies by 90 °C. The temperature of fastening down the rail is about 20 °C and any work affecting the stability of the track is carried out between 13° C and 23 °C.

There is no restriction on the type of sleeper or the type of fastening except that rail anchors must be used in cases where the rail is not rigidly fastened to the sleeper. The use of L.W.Rs. is restricted to straights and flat curves.

Welding by the Flash-butt method in depots into long lengths is preferred to Field welds, but little trouble has been experienced from the latter either of the gas or thermit type.

No special expansion device is used at the ends of L.W.Rs. on the North American Continent. Other railways are experimenting with special expansion joints with definite conclusion yet as to its essentiality.

The economies expected from the use of L.W.Rs. are twofold. The elimination of joints reduces the labour of maintenance by 25 % and L.W.Rs. are expected to have a life 25 % longer than that of a conventional rail.

Table I. — QUESTION I.

TABLE 1. — **Question 1 : Definition of**

RAILWAY	1.1 After what length is the espression «Long welded rail» (L.W.R.) used, meaning a rail the central part of which never undergoes any movement as a result of temperature variations	1.2 GENERAL INFORMATION COLLEC (a) overall length of the principal sections laid with L.W.R.	(b) total cumulative length of the sections so laid compared with the total length of main lines on your system	(c) maximum speed allowed over the L.W.R.	(d) gross daily tonnage on the most important sections	(e) maximum temperature variations 1° annual 2° daily in regions where the L.W.R. are assembled (the temperatures are taken as measured in the rail-head)	(f) kind of sleepers wood, st or concrete number/k
GREAT BRITAIN *British Railways*	91.4 m	1.6 km	31.7 m out of 21 600 m (51 km out of 34 800 km)	144 km/h	60 000 tons	annual - 78°C daily - not stated	Wood or concre 1 310 kr and 1 530 kr
London Transport Executive	91.4 m	804 m	14.5 m out of 480 m	104.6 km/h	80 000 tons	annual - 32.2°C daily - 21.1°C	wood 1 310 kn
AFRICA *South African Railways*	210 m	290 m	1.6 km out of 20 277 km	88 km/h	30 000 tons	annual - 75°C daily - 42°C	steel - 1 240 kn wood - 1 414 kn
NEW ZEALAND *New Zealand Railways*	120 m	questions (a) to (n) not answered as only 75 m rails are used					
SWEDEN *Svenska Järnvägs foreningen*	40 m	150 km of 40 m rails	150 km out of 300 km	90 km/h	12 000 tons	annual - 75°C daily - 25°C	wood - not state
Chemins de fer de l'Etat (State Railw. Board)	100 m	8.6 km	8.6 km out of 12 500 km	90-130 km/h	13 000 to 35 000 tons	annual - 90°C daily - 25°C	wood and concrete 1 550 kn
AUSTRALIA *Victorian Railways*	150 m	150 m and 750 m	experimental lengths only	80-110 km/h	4 000 - 14 000 tons	annual - 50°C daily - unknown	wood not statec
JAPAN *Japanese National Railways*	150 m	72.8 km	72.8 km out of 22 860 km	95 km/h	74 000 tons	annual - 60°C daily - 40°C	wood and concrete 1 760 - 1 9 km

and statistical information.

T L.W.Rs. USED ON MAIN LINES							
(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
method of astening he rails he sleepers	kind of ballast	methods of welding used	are expansion devices used or not?	year when L.W.R. were first introduced	quantity of ballast/km of track?	type of joint at ends of L.W.R.	are rubber pads used between rail seat and sleeper, sleeper chair and sleeper or rail seat and sleeper chair?
various	granite limestone slag	flash-butt	yes	1948	1 250 cub. m/km	expansion joint	yes
st iron irs, screw ikes wood steel keys	crushed limestone	flash-butt	yes	1939	1 200 cub. m/km	expansion joint	no
st iron irs, screw ikes keys n wood	crushed stone	flash-butt	yes	1948	1 300 cub. m/km	normal fishplate suspension joint	no
od screw h spring shers and per chairs	crushed stone and gravel	oxy-acetylene	only on bridges	1936	2 250 cub. m/km	suspended joint with conventional fastenings	no
and elastic spikes r wood Fist » concrete	crushed stone	flash-butt and thermit	only on bridges	1937	1 500 cub. m/km	normal fishplate suspended joint	yes
g spikes on le plates	crushed stone	flash-butt and thermit	no	1937	1 350 cub. m/km	suspended joint with fishplates	no
ge blocks, ing clips, s and nuts concrete eepers. ie plates h spring ; and dog spikes r wood	crushed stone	flash-butt and gas pressure	yes	1950	1 300-1 400 cub. m/km	expansion joint with conventional fastenings	yes

TABLE 1. — **Question 1 : Definition of**

RAILWAY	1.1	1.2 GENERAL INFORMATION COLLEC					
	After what length is the espression «Long welded rail» (L.W.R.) used meaning a rail the central part of which never undergoes any movement as a result of temperature variations	(a) overall length of the principal sections laid with L.W.R.	(b) total cumulative length of the sections so laid compared with the total length of main lines on your system	(c) maximum speed allowed over the L.W.R.	(d) gross daily tonnage on the most important sections	(e) maximum temperature variations 1° annual 2° daily in regions where the L.W.R. are assembled (the temperatures are taken as measured in the rail-head)	(f) kind of sleepers-wood, ste or concrete number/k
NORTH AMERICA							
Association of American Railroads			*1952-55*				
ACL.	not answered	not answered	9.5 km	127 km/h	not stated	not stated	wood slee
C & EI.	» »	» »	4.8 km	128 km/h	» »	» »	»
CSS & SB	» »	» »	6.5 km	127 km/h	» »	» »	»
P & LE.	» »	» »	4.3 km	112 km/h	51 373 tons	» »	»
N & W.	» »	» »	11.6 km	125 km/h	not stated	» »	»
SP & S.	» »	» »	9.4 km	112 km/h	» »	» »	»
EJ & E.	» »	» »	13.5 km	72 km/h	» »	» »	»
Can. Nat.	» »	» »	16.0 km	128 km/h	43 956 tons	» »	»
NYC.	» »	» »	13.2 km	128 km/h	not stated	» »	»
RF & P.	» »	» »	39.8 km	128 km/h	52 186 tons	» »	»
C.R.I. & P.	» »	» »	8.0 km	112 km/h	37 362 tons	» »	»
M.St.P. & S.S.M.	» »	» »	54.0 km	104 km/h	24 725 tons	» »	»
AT & SF.	» »	» »	227.0 km	144 km/h	24 725 to 98 900 tons	» »	»
NP.	» »	» »	119.8 km	120 km/h	not stated	» »	»
TP & W.	» »	» »	31.9 km	none	» »	» »	»

d statistical information *(continuation)*.

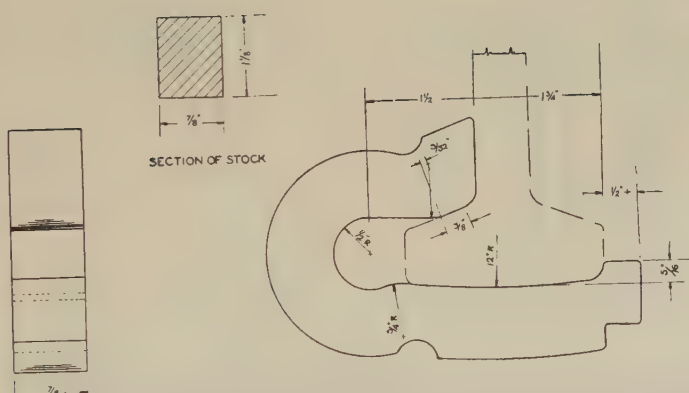
L.W.Rs. USED ON MAIN LINES							
(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
ethod of tening e rails e sleepers	kind of ballast	methods of welding used	are expansion devices used or not?	year when L.W.R. were first introduced	quantity of ballast/km of track?	type of joint at ends of L.W.R.	are rubber pads used between rail seat and sleeper, sleeper chair and sleeper or rail seat and sleeper chair?
; spikes and n screws	crushed granite	not stated	no	not stated	not stated	normal fishplate suspension joint	no
»	slag	» »	»	» »	» »	» »	»
»	stone	» »	»	» »	» »	» »	»
»	crushed slag	» »	»	» »	» »	» »	»
»	crushed limestone	» »	»	» »	» »	» »	»
»	crushed rock	» »	»	» »	» »	» »	»
»	crushed stone 3/4" - 1 1/2"	» »	»	» »	» »	» »	»
»	crushed rock	» »	»	» »	» »	normal fishplate suspension joint	»
»	stone	» »	»	» »	» »	» »	»
»	granite stone 1 3/4" - 3/4"	» »	»	» »	» »	» »	»
»	slag	» »	»	» »	» »	» »	»
»	processed gravel	» »	»	» »	» »	» »	»
»	blast furnace slag, quartsite, volcanic cinder	» »	»	» »	» »	» »	»
»	crushed rock	» »	»	» »	» »	» »	»
»	slag	» »	»	» »	» »	» »	»

TABLE 2.

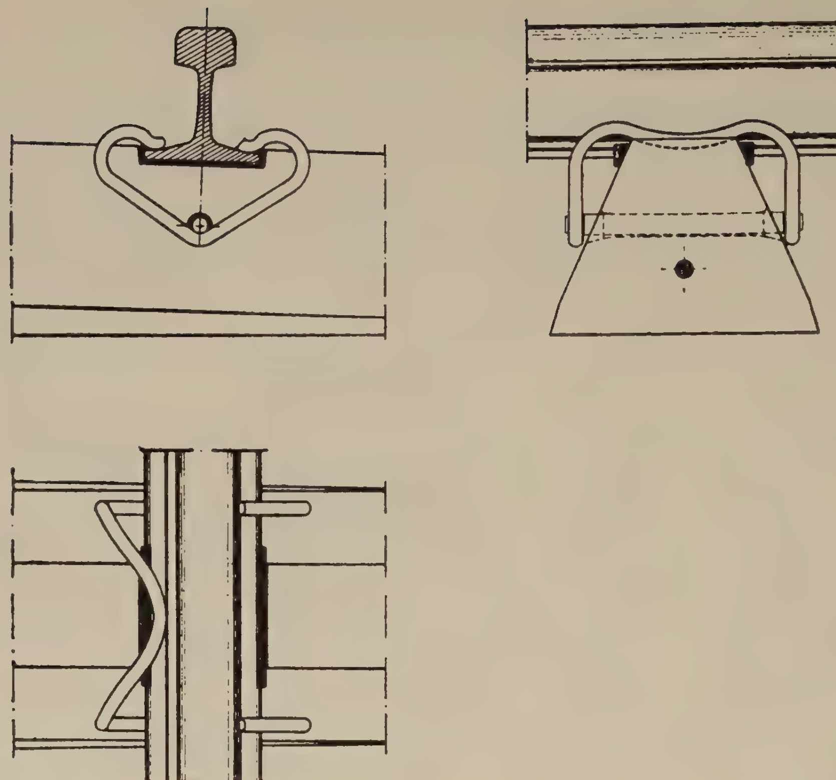
<table>
<tr><td rowspan="2">Rail temperature

Kinds of operation prohibited</td><td>More than 20° C above laying temperature</td><td>Up to 20° C above laying temperature</td><td>± 5° C to laying temperature</td><td>Down to 15° C below laying temperature</td><td>More than 15° C below laying temperature</td></tr>
<tr><td>higher than 45° C</td><td>30° - 45° C</td><td>20° - 30° C</td><td>20° - 10° C</td><td>lower than 10° C</td></tr>
<tr><td>Operation on ballast</td><td>1. Scraping out ballast
2. Taking out dips
3. Out - of - face surfacing
4. Raising & lowering
5. Adjusting alignment
6. Ballast replacement
7. Ballast screening
8. Sleeper replacement
9. Sleeper adjustment
10. Re-canting
11. Others similar works</td><td>1. Scraping out ballast around ends of sleeper
2. Scraping out ballast down to bottom of sleepers in between; five or less consecutive sleepers
3. Out - of - face surfacing
4. Raising & lowering
5. Adjusting alignment
6. Ballast replacement
7. Sleeper replacement
8. Ballast screening
9. Sleeper adjustment
10. Re-canting</td><td></td><td></td><td>1. Raising & lowering
2. Ballast replacement
3. Ballast screening
4. Recanting (when necessary ballast replacement and screening are done at every other sleeper)</td></tr>
<tr><td>Operation on joints</td><td colspan="2">1. Joint bar replacement
2. Loosening or removing fish bolts
3. Loosening or removing consecutive spring fastenings</td><td></td><td colspan="2">1. Joint bar replacement.
2. Loosening or removing fish bolts
3. Loosening or removing consecutive spring fastenings</td></tr>
<tr><td>Others</td><td colspan="2">1. Adjustment of rail tilting
2. Replacement or end-for-end changing of tie pads</td><td></td><td colspan="2">1. Replacement or end-for-end changing of consecutive tie pads</td></tr>
</table>

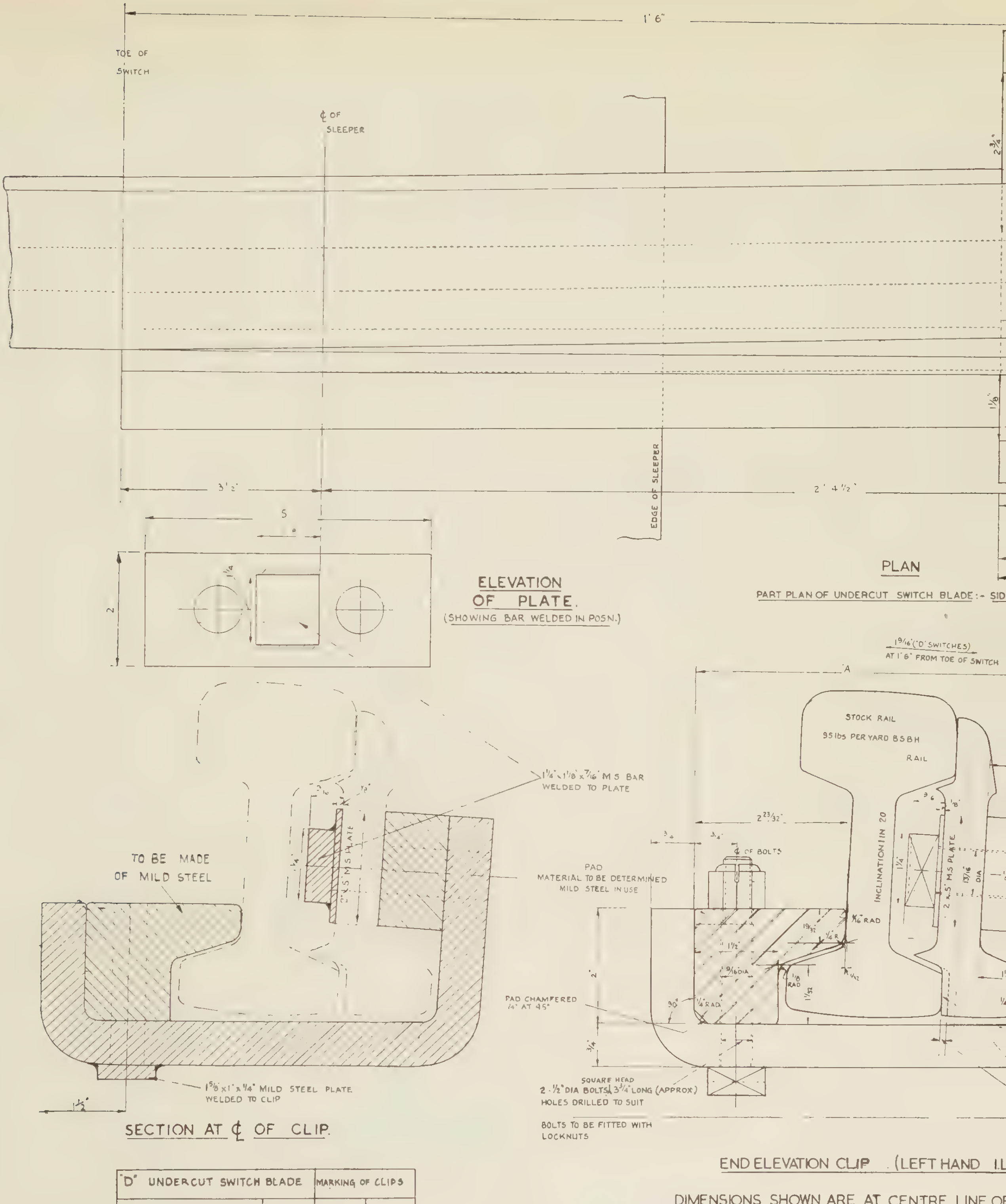
ANNEXURE N° 1*a*.



British Railways. — New Works Standards - 1945.
Rail anchor for 95 lbs. peryd. B.S. bull head rail (Phillips type)

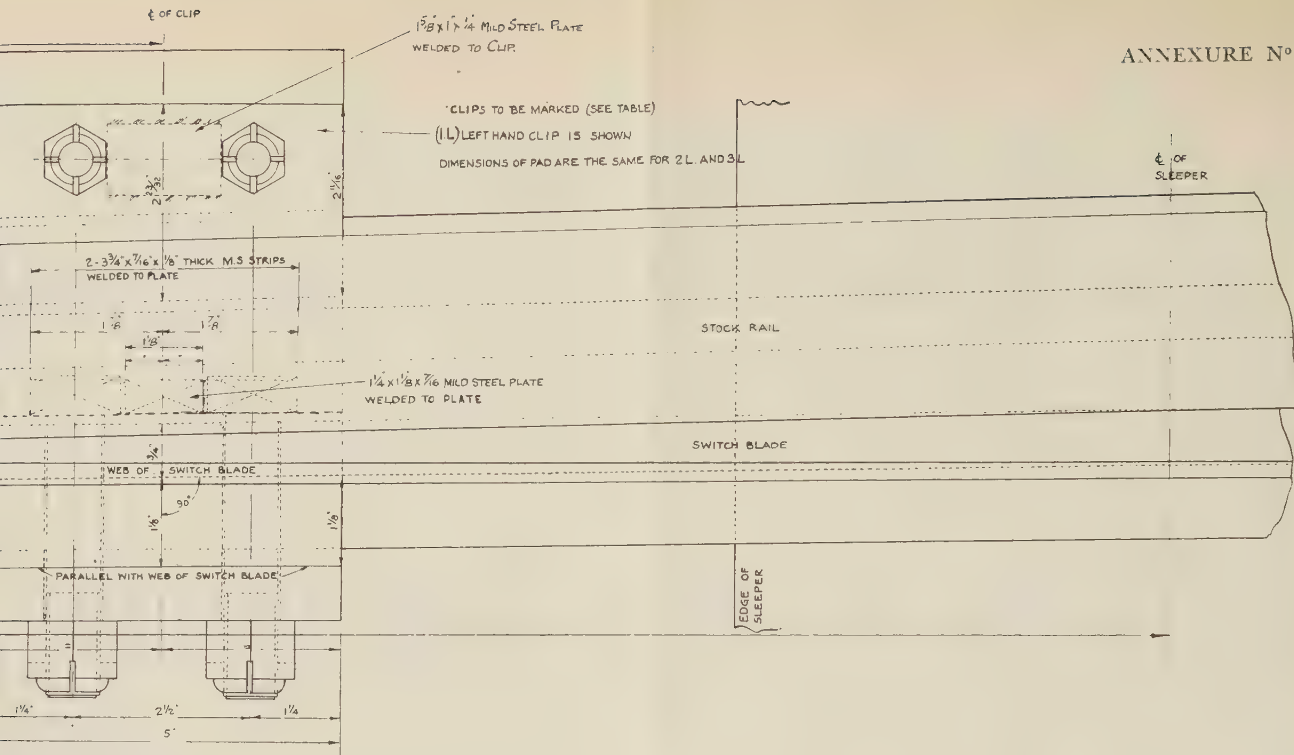


Swedish State Railways. — Rail fastening « FIST »
for concrete sleeper.

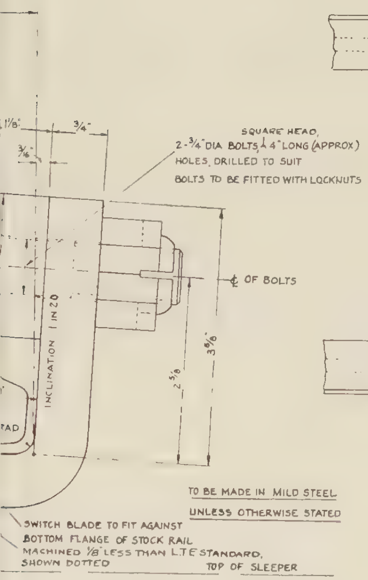


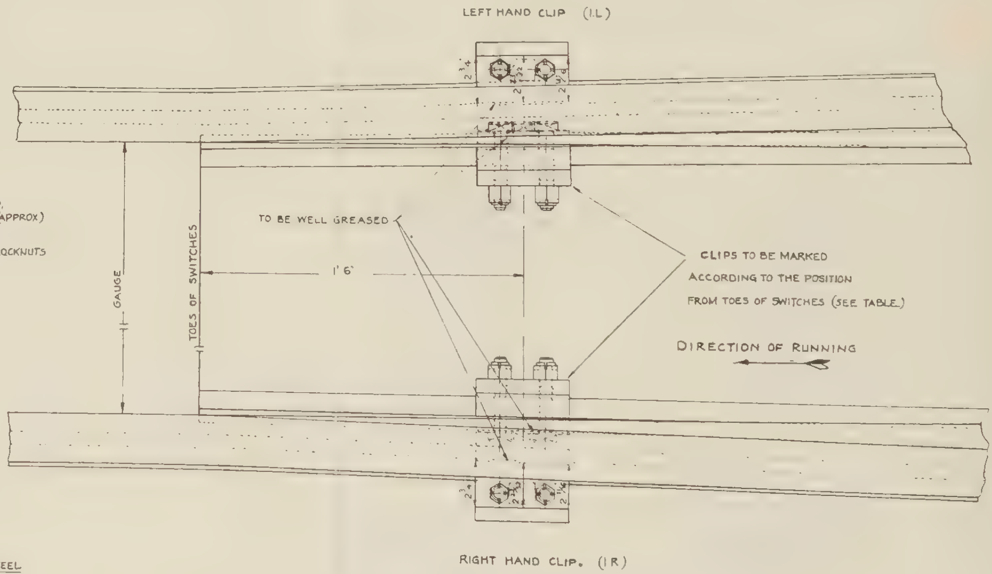
"D" UNDERCUT SWITCH BLADE		MARKING OF CLIPS	
DISTANCE FROM TOES OF SWITCHES TO CENTRE OF CLIP	"A"	LEFT HAND	RIGHT HAND
1'-6"	6 1/16"	1. L.	1 R.
3'-9"	6 11/32"	2 L	2 R
8'-6	6 15/16"	3 L	3 R

London Tr
Clip for special joint using « D » sœitch bl
Scales - Full size a



PLANING 11'0"('D' SWITCHES)





PLAN SHOWING No.1 RIGHT AND LEFT HAND CLIPS

SCALE. 3 INCHES TO 1 FOOT.

)

CLIP.

FOR ARRANGEMENT OF SPECIAL JOINT SEE DRG No.P. 2626 E.

NOTE

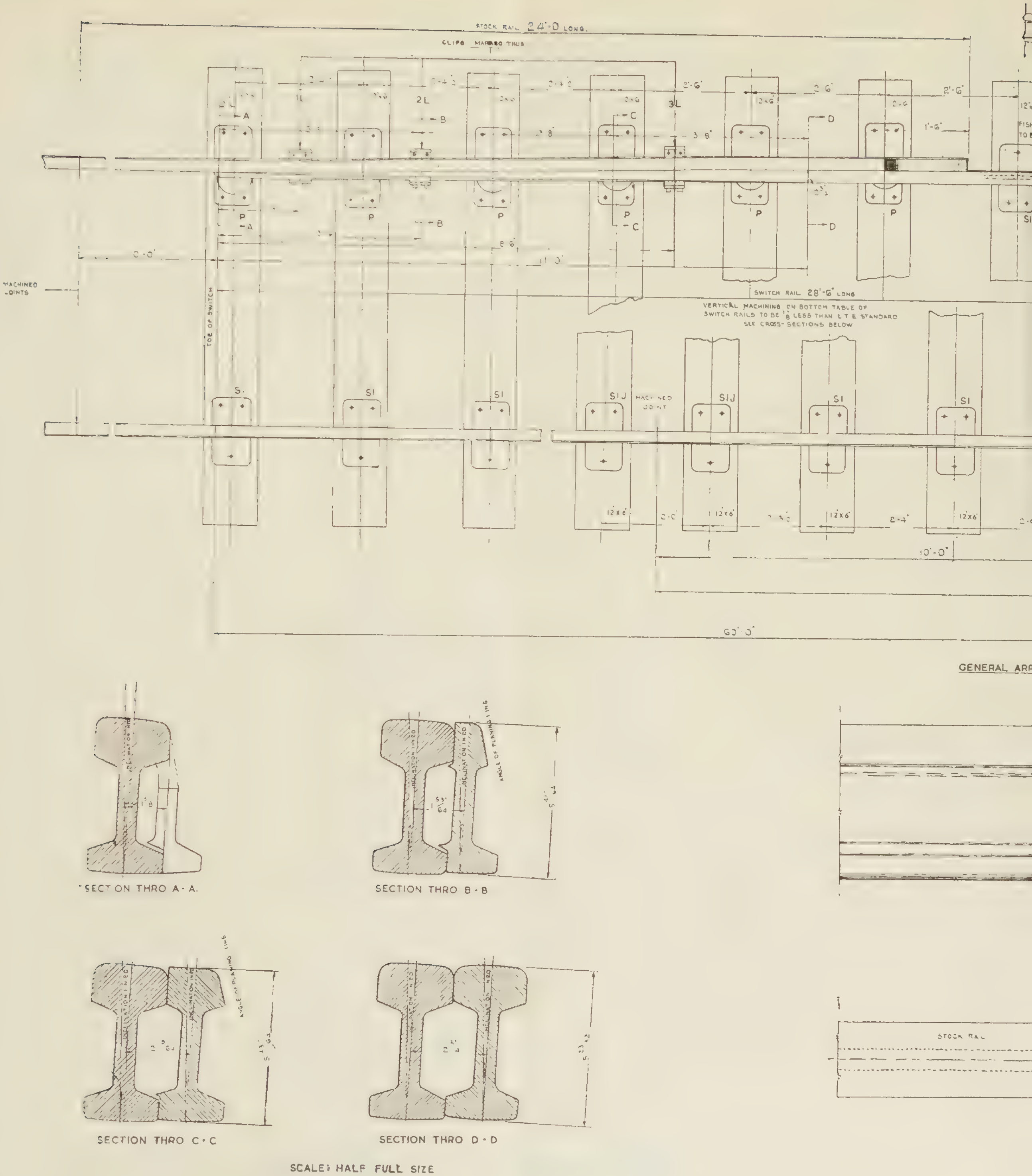
EXPANSION JOINTS TO BE STAGGERED 60 FEET APART.

L SIZE

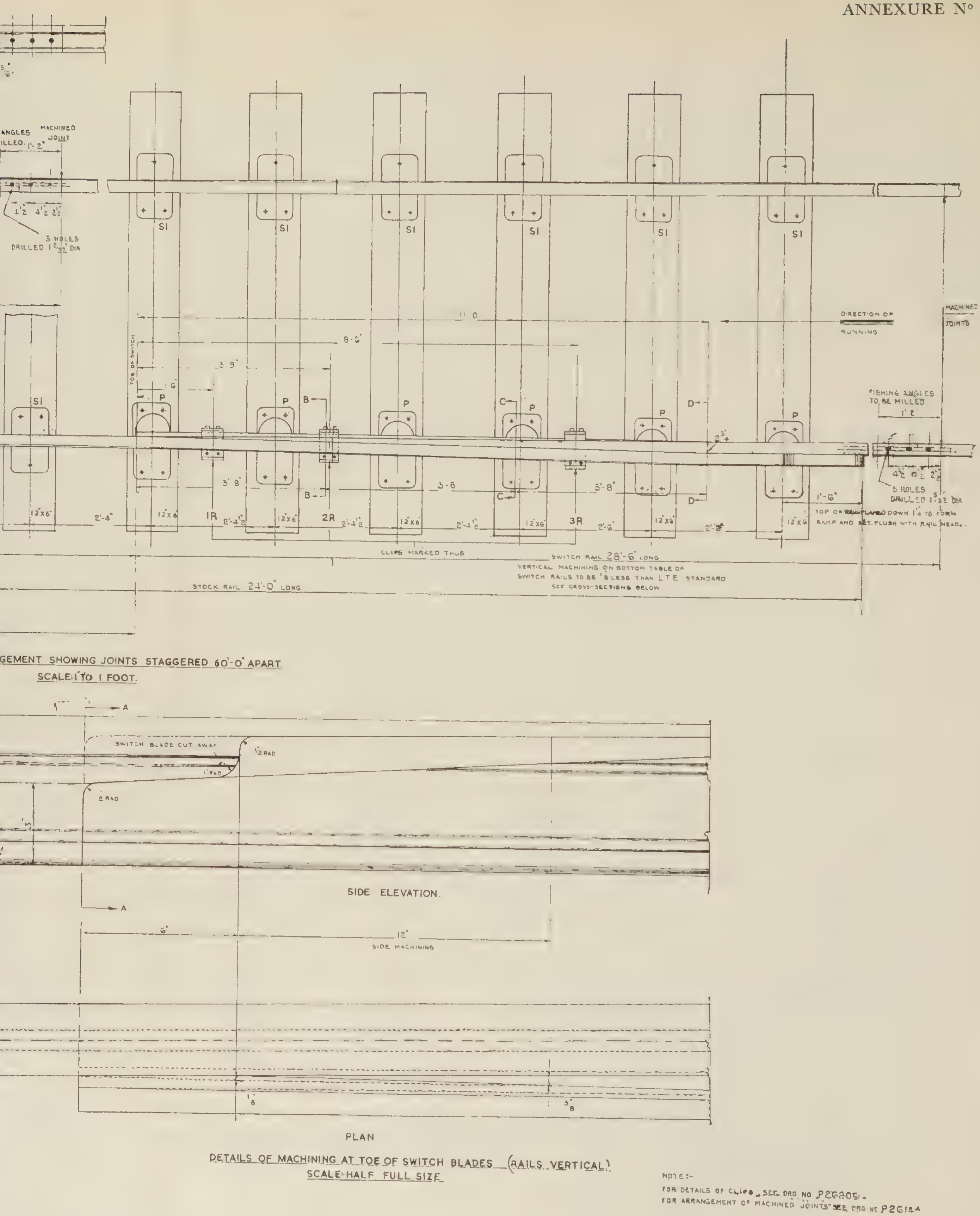
nsport Executive.

ades (undercut) - 95 lb - per yard B.S.B.H. rail.

nd 3 inches to 1 foot.



London Transpo
Arrangement of « D » undercut expansio

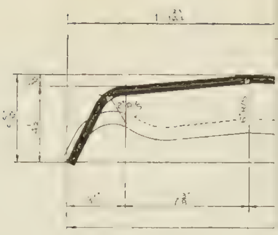


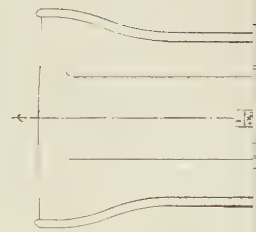
Executive.

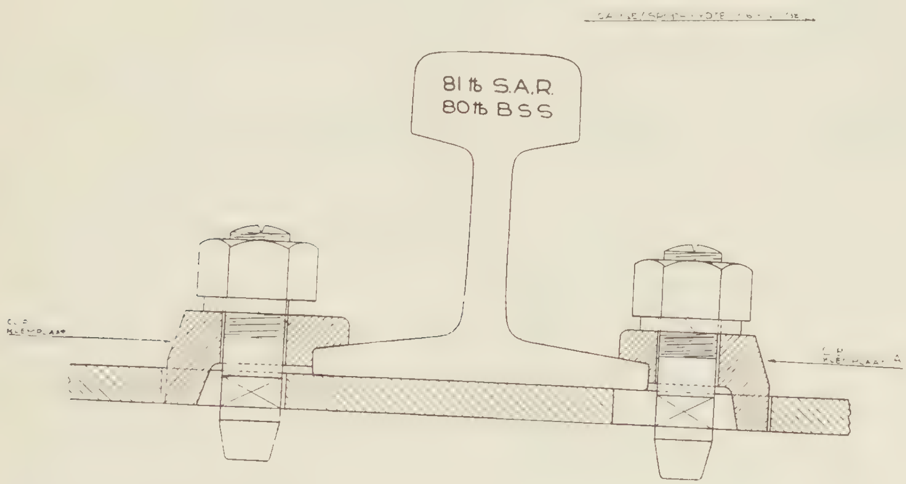
switch - with details of machining.

CROSS SECTION.
DWARSDEURSNEE.
SCALE - FULL SIZE
SKAAL - WARE GROOTTE

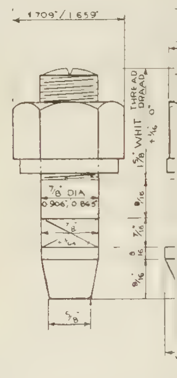
NESTING DIAGRAM. / STAPELDIAGRAM.
SCALE - 3" = 1'-0" SKAAL - 3" = 1'-0"







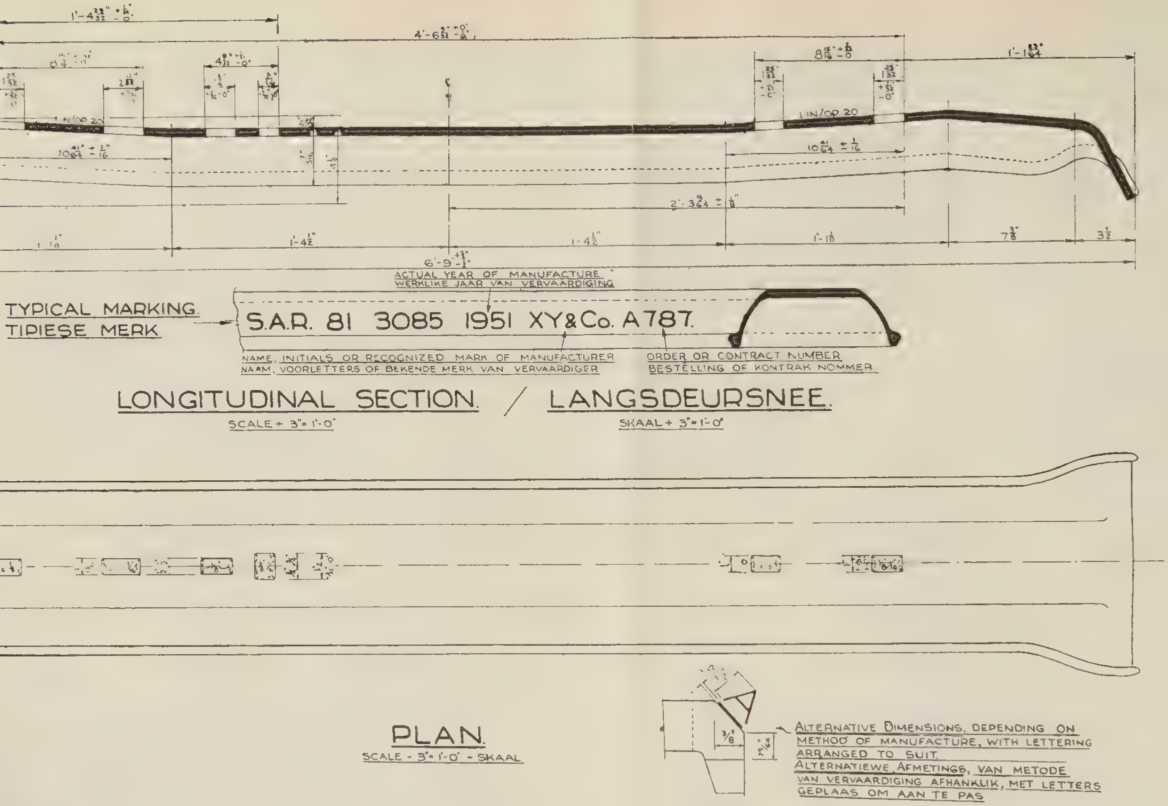
TYPICAL DETAIL OF RAIL FASTENING TO SLEEPER.
TIPIESE DETAIL VAN HEG VAN SPOORSTAAF AAN DWARSLÊER
SCALE - FULL SIZE SKAAL WARE GROOTTE

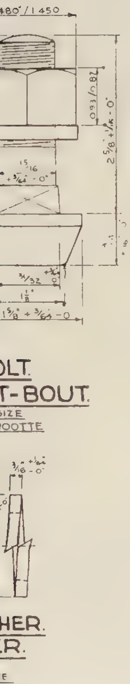


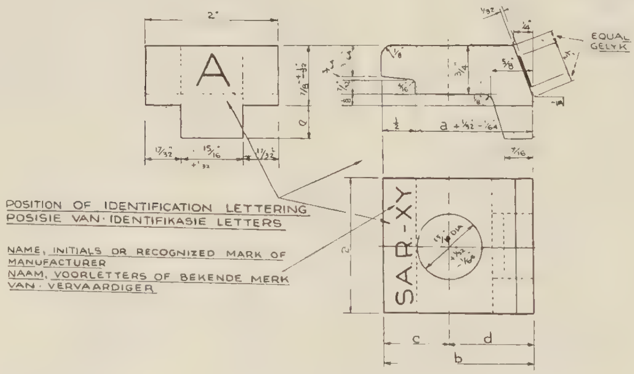
CLIP B
KLEMPLAA
SCALE + FULL
SKAAL + WARE

SPRING WAS
VEERWAST
SCALE - FULL SIZ
SKAAL + WARE GROO

S.A.R. — 81 lb S.A.R. track







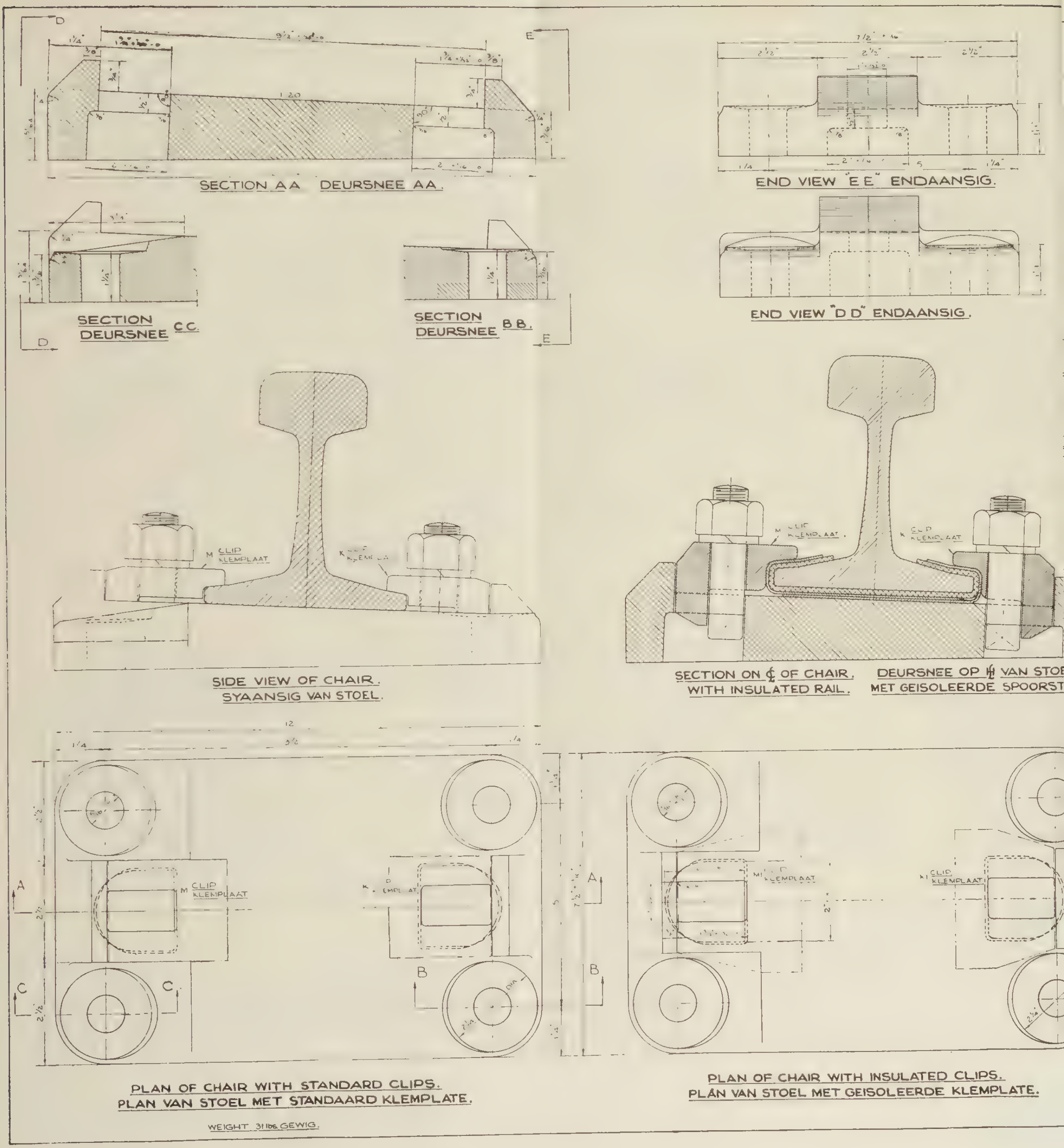
TYPICAL CLIP.
TIPIESE KLEMPLAAT.
SCALE FULL SIZE
SKAAL - WARE GROOTTE

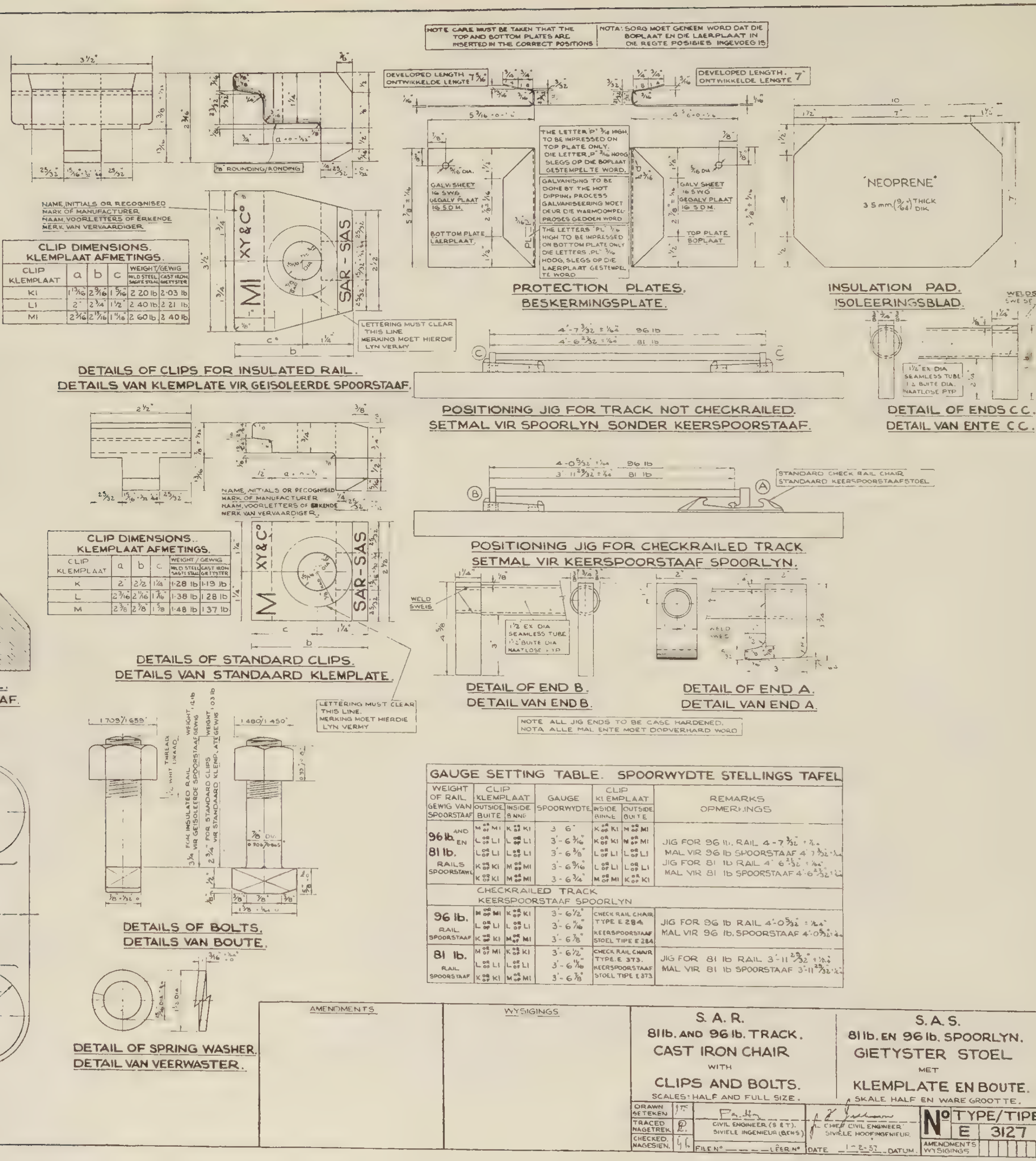
CLIP DETAILS KLEMPLAAT DETAILS					
CLIP KLEMPLAAT	DIMENSIONS / AFMETINGS				
	a	b	c	d	e
A	1¾"	2¼"	1"	1¼"	½"
B	1 15/16"	2 7/16"	1 3/16"	1¼	½"
C	2⅛"	2⅝"	1⅜	1¼"	½"
D	2 5/16"	2 13/16"	1 9/16"	1¼"	½"
E	1 9/16"	2 1/16"	1 1/32"	1 1/32"	1"

NOTE THE CLIPS, CLIP BOLTS, AND SPRING WASHERS SHOWN ON DRAWING TYPE E 295 ARE IDENTICAL TO THOSE SHOWN ON THIS DRAWING

NOTA DIE KLEMPLATE, KLEMPLAAT-BOUTE EN VEERWASTERS OP TEKENING TYPE E-295 GEWYS, IS DIESELFDE AS DIE OP HIERDIE TEKENING. GEWYS.

– Steel sleeper and fastenings.


SECTION AA DEURSNEE AA.
END VIEW "E E" ENDAANSIG.
END VIEW "D D" ENDAANSIG.
SECTION DEURSNEE CC.
SECTION DEURSNEE BB.
CLIP KLEMPLAAT
SIDE VIEW OF CHAIR.
SYAANSIG VAN STOEL.
SECTION ON ℄ OF CHAIR. WITH INSULATED RAIL.
DEURSNEE OP ℄ VAN STOE
MET GEISOLEERDE SPOORST
PLAN OF CHAIR WITH STANDARD CLIPS.
PLAN VAN STOEL MET STANDAARD KLEMPLATE.
WEIGHT 31lbs. GEWIG.
PLAN OF CHAIR WITH INSULATED CLIPS.
PLAN VAN STOEL MET GEISOLEERDE KLEMPLATE.



CLIP DIMENSIONS. KLEMPLAAT AFMETINGS.					
CLIP KLEMPLAAT	a	b	c	WEIGHT/GEWIG MILD STEEL SAGTE STAAL	WEIGHT/GEWIG CAST IRON GIETYSTER
K1	1 13/16"	2 9/16"	1 5/16"	2.20 lb	2.03 lb
L1	2"	2 3/4"	1 1/2"	2.40 lb	2.21 lb
M1	2 3/16"	2 15/16"	1 11/16"	2.60 lb	2.40 lb

CLIP DIMENSIONS. KLEMPLAAT AFMETINGS.					
CLIP KLEMPLAAT	a	b	c	WEIGHT/GEWIG MILD STEEL SAGTE STAAL	WEIGHT/GEWIG CAST IRON GIETYSTER
K	2"	2 1/2	1 1/4"	1.28 lb	1.19 lb
L	2 3/16"	2 11/16"	1 7/16"	1.38 lb	1.28 lb
M	2 3/8"	2 7/8"	1 5/8	1.48 lb	1.37 lb

GAUGE SETTING TABLE. SPOORWYDTE STELLINGS TAFEL

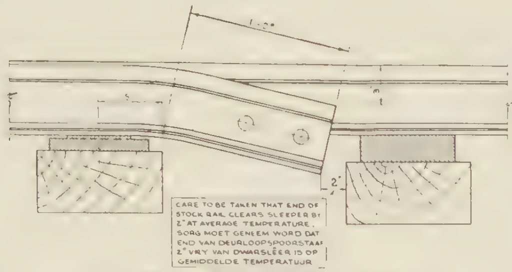
WEIGHT OF RAIL GEWIG VAN SPOORSTAAF	CLIP KLEMPLAAT OUTSIDE BUITE	CLIP KLEMPLAAT INSIDE BINNE	GAUGE SPOORWYDTE	CLIP KLEMPLAAT INSIDE BINNE	CLIP KLEMPLAAT OUTSIDE BUITE	REMARKS OPMERKINGS
96 lb. AND EN 81 lb. RAILS SPOORSTAWE	M or/of M1	K or/of K1	3' 6"	K or/of K1	M or/of M1	
	L or/of L1	L or/of L1	3'-6 3/16"	K or/of K1	M or/of M1	JIG FOR 96 lb. RAIL 4'-7 3/32" ± 1/64" MAL VIR 96 lb SPOORSTAAF 4' 7 3/32" ± 1/64"
	L or/of L1	L or/of L1	3'-6 3/8"	L or/of L1	L or/of L1	JIG FOR 81 lb RAIL 4' 6 23/32" ± 1/64" MAL VIR 81 lb SPOORSTAAF 4'-6 23/32" ± 1/64"
	K or/of K1	M or/of M1	3'-6 9/16"	L or/of L1	L or/of L1	
	K or/of K1	M or/of M1	3'-6 3/4"	M or/of M1	K or/of K1	
CHECKRAILED TRACK KEERSPOORSTAAF SPOORLYN						
96 lb. RAIL SPOORSTAAF	M or/of M1	K or/of K1	3'-6 1/2"	CHECK RAIL CHAIR TYPE E 284		JIG FOR 96 lb RAIL 4'-0 5/32" ± 1/64" MAL VIR 96 lb. SPOORSTAAF 4'-0 5/32" ± 1/64"
	L or/of L1	L or/of L1	3'-6 11/16"	KEERSPOORSTAAF STOEL TIPE E 284		
	K or/of K1	M or/of M1	3'-6 7/8"			
81 lb. RAIL SPOORSTAAF	M or/of M1	K or/of K1	3'-6 1/2"	CHECK RAIL CHAIR TYPE E 373.		JIG FOR 81 lb RAIL 3'-11 29/32" ± 1/64" MAL VIR 81 lb SPOORSTAAF 3'-11 29/32" ± 1/64"
	L or/of L1	L or/of L1	3'-6 11/16"	KEERSPOORSTAAF STOEL TIPE E 373		
	K or/of K1	M or/of M1	3'-6 7/8"			

AMENDMENTS | WYSIGINGS

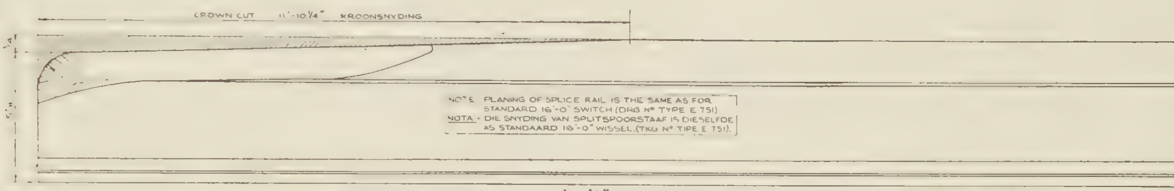
S. A. R.
81 lb. AND 96 lb. TRACK.
CAST IRON CHAIR
WITH
CLIPS AND BOLTS.
SCALES: HALF AND FULL SIZE.

S. A. S.
81 lb. EN 96 lb. SPOORLYN.
GIETYSTER STOEL
MET
KLEMPLATE EN BOUTE.
SKALE HALF EN WARE GROOTTE.

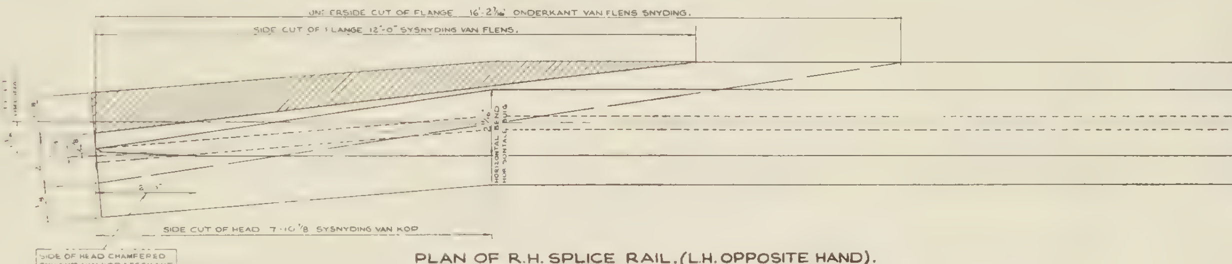
DRAWN GETEKEN		CIVIL ENGINEER (S & T). SIVIELE INGENIEUR (BENS)	CHIEF CIVIL ENGINEER. SIVIELE HOOFINGENIEUR.	No. TYPE/TIPE E 3127
TRACED NAGETREK				
CHECKED NAGESIEN		FILE No. ——— LÊER No.	DATE 1-2-57 DATUM.	AMENDMENTS WYSIGINGS



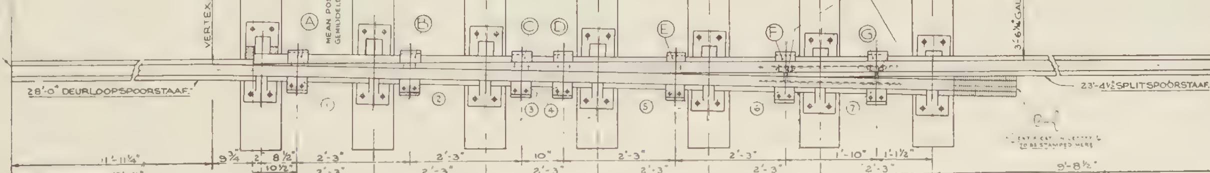
DETAIL AT END OF STOCK RAIL.
DETAIL OP END VAN DEURLOOPSPOORSTAAF.
SCALE 3"=1'-0". SKAAL 3"=1'-0".



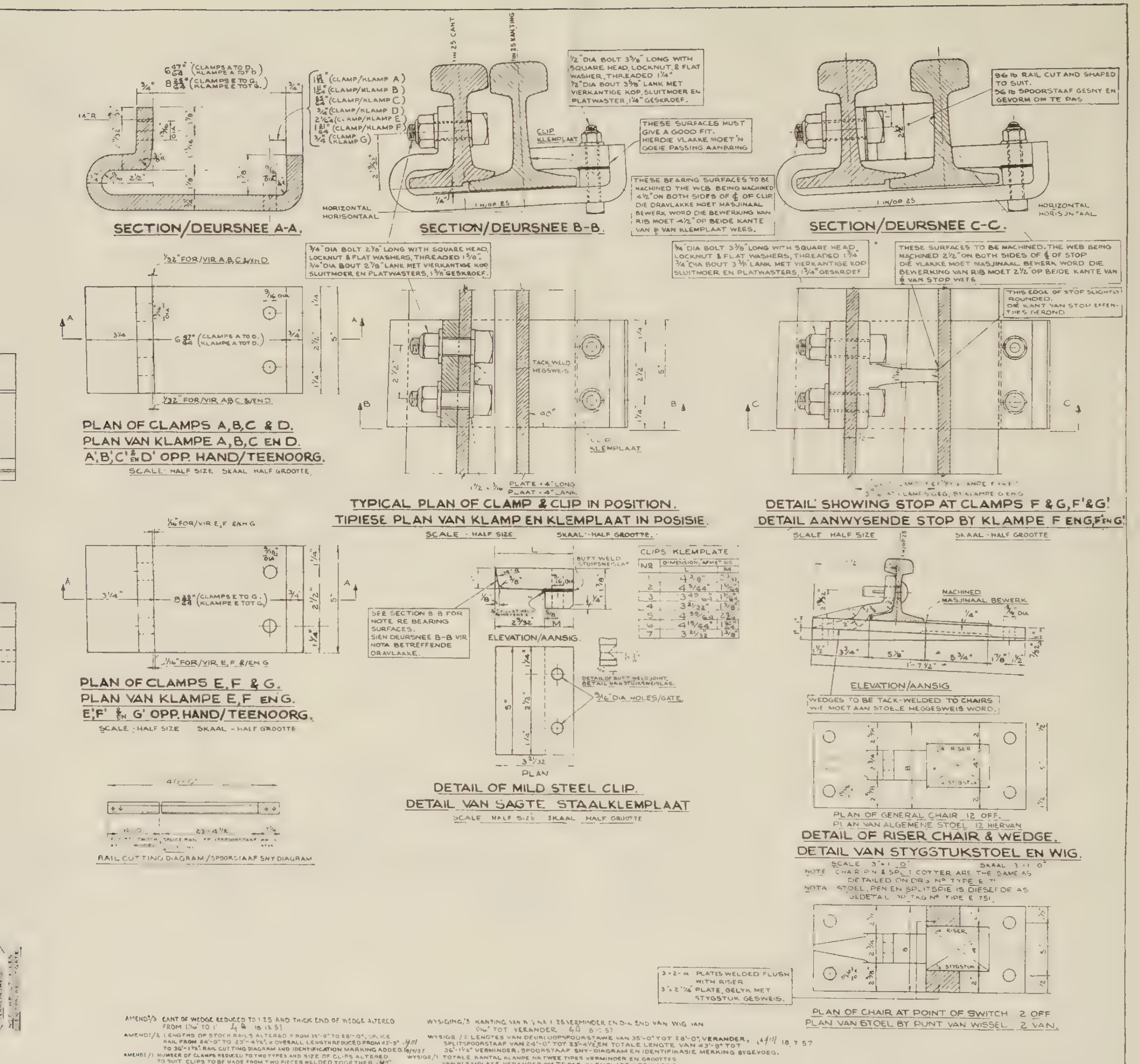
SIDE ELEVATION OF 23'-4½" SPLICE RAIL.
SYAANSIG VAN 23'-4½" SPLITSPOORSTAAF.
SCALES 1"=1'-0" HOR & 6"=1'-0" VER.
SKALE 1"=1'-0" HOR EN 6"=1'-0" VER.



PLAN OF R.H. SPLICE RAIL. (L.H. OPPOSITE HAND).
PLAN VAN R.H. SPLITSPOORSTAAF. (L.H. TEENOORGESTELD).
SCALES 1"=1'-0" HOR & 6"=1'-0" VER.
SKALE 1"=1'-0" HOR EN 6"=1'-0" VER.



GENERAL ARRANGEMENT OF SPLICE JOINT.
ALGEMENE RANGSKIKKING VAN SPLITLAS.
SCALE 1"=1'-0". SKAAL 1"=1'-0".



NOTES	NOTA.
1. ALL MOVING PARTS TO BE WELL GREASED.	1. ALLE BEWEGENDE DELE MOET DEEGLIK MET GHRIES GESMEER WORD.
2. DURING MANUFACTURE CARE MUST BE TAKEN THAT, WITH SWITCH IN MEAN POSITION THE CLAMPS ARE PARALLEL TO AND 2" CLEAR OF ADJACENT RISER CHAIRS.	2. GEDURENDE VERVAARDIGING MOET GESORG WORD DAT MET DIE WISSEL IN DIE MIDDELSTE POSISIE DIE KLAMPE PARALLEL MET EN 2" VRY VAN AANGRENSENDE STYGSTOELE IS.
3. 'A' TYPE COACHSCREWS, ONLY, TO BE USED FOR SECURING RISER CHAIRS.	3. SLEGS TIPE 'A' SPOORSKROEWE MOET GEBRUIK WORD OM STYGSTUKSTOELE IN PLEK VAS TE MAAK.

S.A.R.	S.A.S.
96 lb. S.A.R. TRACK UNI-DIRECTIONAL SPLICE JOINT WITH ± 2" MOVEMENT.	96 lb. S.A.S. SPOORLYN. EENRIGTING SPLITLAS MET ± 2" BEWEGING
SCALES AS SHOWN	SKALE SOOS AANGEDUI.

DRAWN GETEKEN · TRACED NAGETREK · CHECKED NAGESIEN

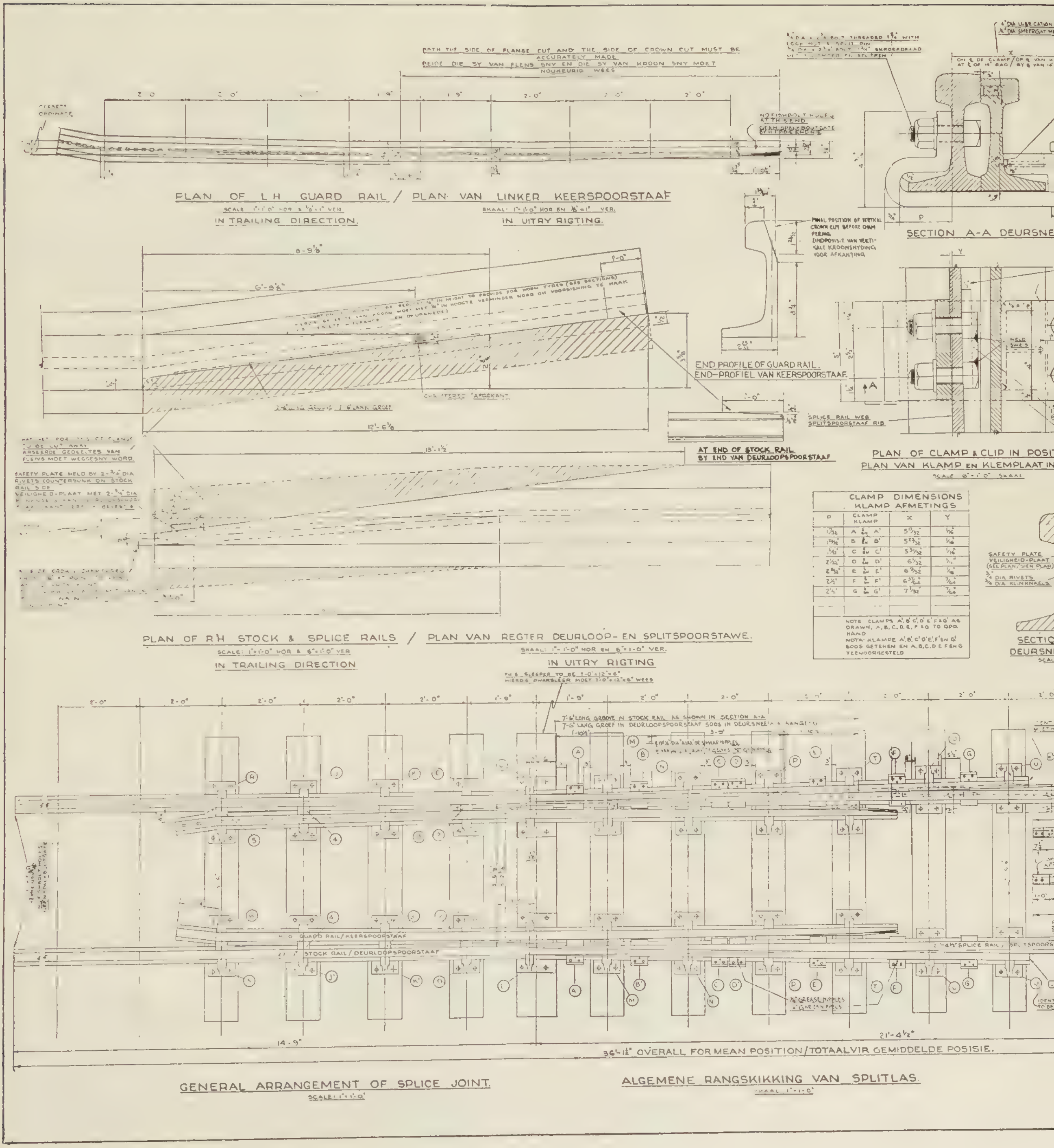
CIVIL ENGINEER (S & T) SIVIELE INGENIEUR (S & S) · CHIEF CIVIL ENGINEER SIVIELE HOOFINGENIEUR

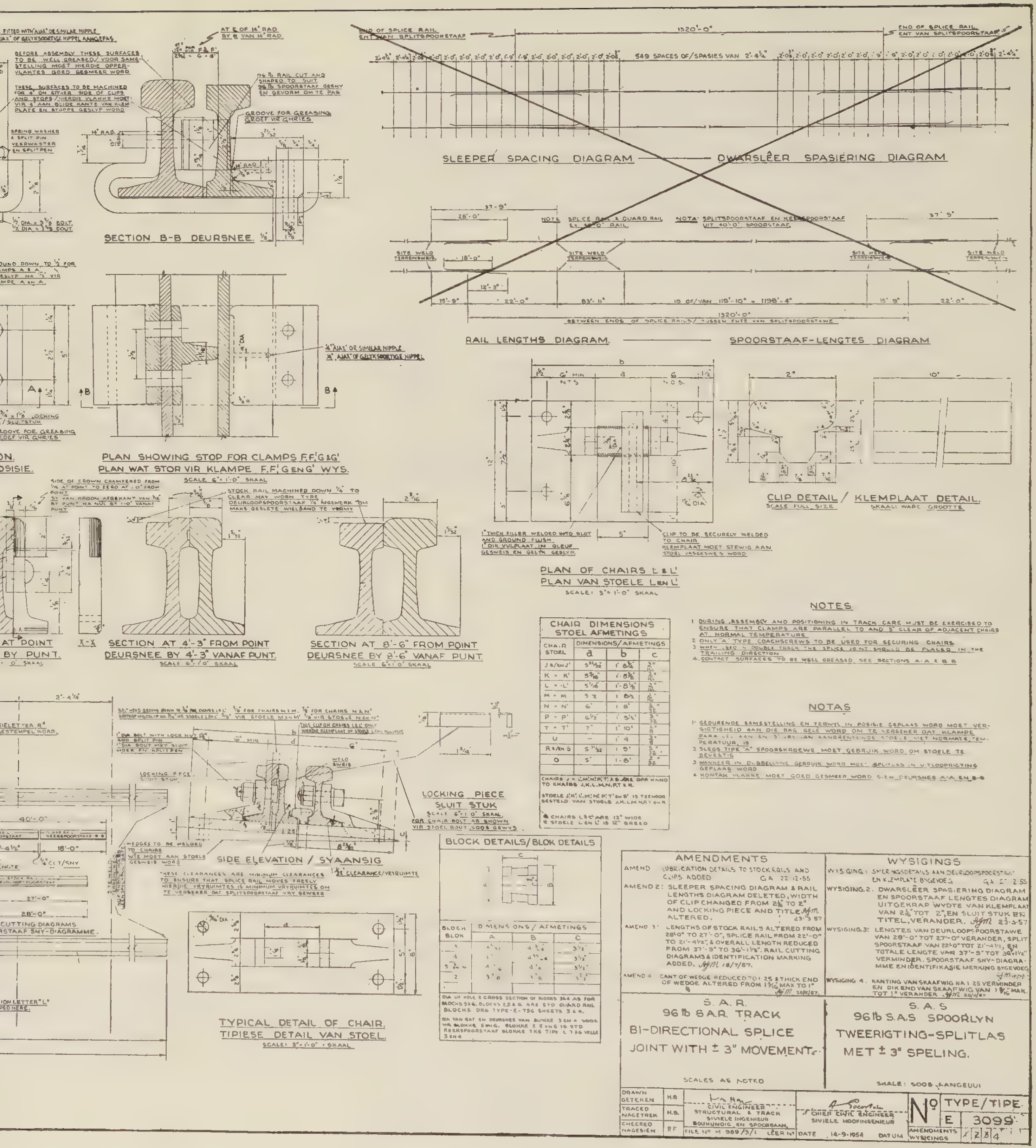
DATE ... DATUM

N° TYPE/TIPE E 3130

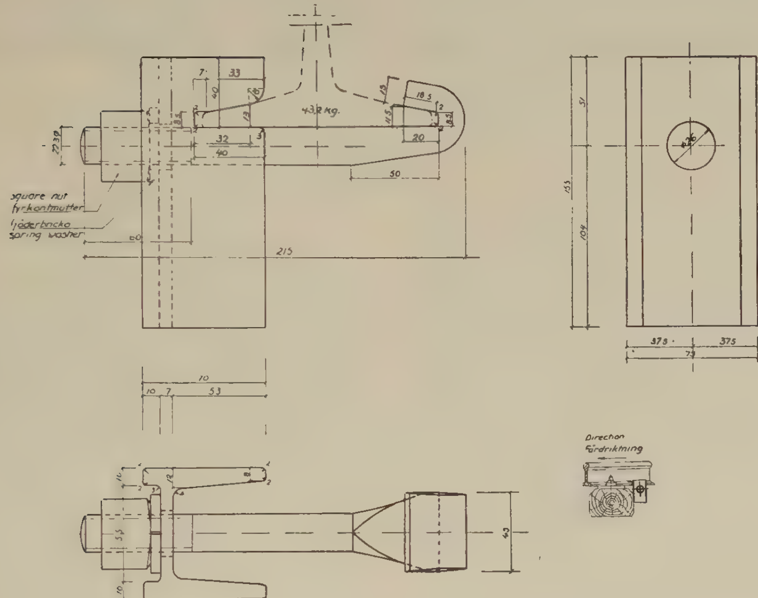
AMENDMENTS WYSIGINGS 1 2 3

ANNEXURE I


BOTH THE SIDE OF FLANGE CUT AND THE SIDE OF CROWN CUT MUST BE ACCURATELY MADE
BEIDE DIE SY VAN FLENS SNY EN DIE SY VAN KROON SNY MOET NOUKEURIG WEES
PLAN OF L.H. GUARD RAIL / PLAN VAN LINKER KEERSPOORSTAAF
IN TRAILING DIRECTION.
IN UITRY RIGTING.
END PROFILE OF GUARD RAIL.
END-PROFIEL VAN KEERSPOORSTAAF.
SPLICE RAIL WEB
SPLITSPOORSTAAF RIB
AT END OF STOCK RAIL
BY END VAN DEURLOOPSPOORSTAAF
SECTION A-A DEURSNE
PLAN OF CLAMP & CLIP IN POSI
PLAN VAN KLAMP EN KLEMPLAAT IN
CLAMP DIMENSIONS
KLAMP AFMETINGS
P | CLAMP KLAMP | X | Y
1 7/32 | A EN A' | 5 17/32" | 1/16"
1 24/32" | B EN B' | 5 23/32" | 1/16"
1 3/32" | C EN C' | 5 31/32" | 1/16"
2 1/32" | D EN D' | 6 1/32" | 1/16"
2 9/32" | E EN E' | 6 9/32" | 1/16"
2 1/4" | F EN F' | 6 57/64" | 7/64"
2 1/4" | G EN G' | 7 1/32" | 7/64"
NOTE CLAMPS A', B', C', D', E', F' & G' AS DRAWN, A, B, C, D, E, F & G TO OPP. HAND
NOTA: KLAMPE A', B', C', D', E', F' EN G' SOOS GETEKEN EN A, B, C, D, E, F EN G TEENOORGESTELD.
SAFETY PLATE
VEILIGHEID-PLAAT
PLAN OF R.H. STOCK & SPLICE RAILS / PLAN VAN REGTER DEURLOOP- EN SPLITSPOORSTAWE.
IN TRAILING DIRECTION
IN UITRY RIGTING
GUARD RAIL / KEERSPOORSTAAF
STOCK RAIL / DEURLOOPSPOORSTAAF
36'-1½" OVERALL FOR MEAN POSITION / TOTAAL VIR GEMIDDELDE POSISIE.
GENERAL ARRANGEMENT OF SPLICE JOINT.
SCALE: 1"=1'-0"
ALGEMENE RANGSKIKKING VAN SPLITLAS.
SKAAL 1"=1'-0"

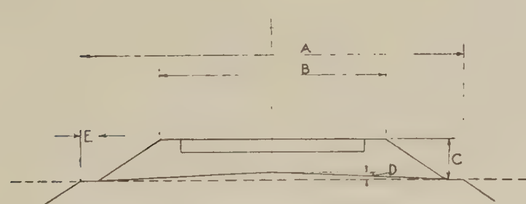

SECTION B-B DEURSNEE.
PLAN SHOWING STOP FOR CLAMPS F.F.'G & G'
PLAN WAT STOP VIR KLAMPE F.F.' G EN G' WYS.
SCALE 6"-1'-0" SKAAL
SECTION AT 4'-3" FROM POINT
DEURSNEE BY 4'-3" VANAF PUNT.
SCALE 6"-1'-0" SKAAL
SECTION AT 8'-6" FROM POINT
DEURSNEE BY 8'-6" VANAF PUNT.
SCALE 6"-1'-0" SKAAL
SLEEPER SPACING DIAGRAM — DWARSLÊER SPASIËRING DIAGRAM
RAIL LENGTHS DIAGRAM. — SPOORSTAAF-LENGTES DIAGRAM
PLAN OF CHAIRS L & L'
PLAN VAN STOELE L en L'
SCALE: 3"-1'-0" SKAAL
CLIP DETAIL / KLEMPLAAT DETAIL.
SCALE FULL SIZE
SKAAL: WARE GROOTTE
CLIP TO BE SECURELY WELDED TO CHAIR
KLEMPLAAT MOET STEWIG AAN STOEL VASGESWEIS WORD
CHAIR DIMENSIONS
STOEL AFMETINGS
LOCKING PIECE
SLUIT STUK
SIDE ELEVATION / SYAANSIG
BLOCK DETAILS/BLOK DETAILS
TYPICAL DETAIL OF CHAIR.
TIPIESE DETAIL VAN STOEL.
SCALE: 3"-1'-0" SKAAL
CUTTING DIAGRAMS
SPOORSTAAF SNY-DIAGRAMME.
NOTES
1 DURING ASSEMBLY AND POSITIONING IN TRACK CARE MUST BE EXERCISED TO ENSURE THAT CLAMPS ARE PARALLEL TO AND 3" CLEAR OF ADJACENT CHAIRS AT NORMAL TEMPERATURE
2 ONLY "A" TYPE COACHSCREWS TO BE USED FOR SECURING CHAIRS
3 WHEN USED IN DOUBLE TRACK THE SPLICE JOINT SHOULD BE PLACED IN THE TRAILING DIRECTION
4. CONTACT SURFACES TO BE WELL GREASED. SEE SECTIONS A-A & B-B
NOTAS
1 GEDURENDE SAMESTELLING EN TERWYL IN POSISIE GEPLAAS WORD MOET VERSIGTIGHEID AAN DIE DAG GELÊ WORD OM TE VERSEKER DAT KLAMPE PARALLEL AAN EN 3" VRY VAN AANGRENSENDE STOELE, MET NORMALE TEMPERATUUR, IS
2 SLEGS TIPE "A" SPOORSKROEWE MOET GEBRUIK WORD OM STOELE TE BEVESTIG
3 WANNEER IN DUBBELLYNE GEBRUIK WORD MOET SPLITLAS IN UITLOOPRIGTING GEPLAAS WORD
4 KONTAK VLAKKE MOET GOED GESMEER WORD SIEN DEURSNEE A-A EN B-B
AMENDMENTS
AMEND 1: LUBRICATION DETAILS TO STOCK RAILS AND CLIPS ADDED GA 22-12-55
AMEND 2: SLEEPER SPACING DIAGRAM & RAIL LENGTHS DIAGRAM DELETED, WIDTH OF CLIP CHANGED FROM 2 1/16" TO 2" AND LOCKING PIECE AND TITLE ALTERED. 23-3-57
AMEND 3: LENGTHS OF STOCK RAILS ALTERED FROM 28'-0" TO 27'-0", SPLICE RAIL FROM 22'-0" TO 21'-4½", & OVERALL LENGTH REDUCED FROM 37'-9" TO 36'-1½". RAIL CUTTING DIAGRAMS & IDENTIFICATION MARKING ADDED. 18/7/57.
AMEND 4: CANT OF WEDGE REDUCED TO 1:25 & THICK END OF WEDGE ALTERED FROM 1 1/16" MAX TO 1". 20/11/57.
WYSIGINGS
WYSIGING 1: SMERINGSDETAILS AAN DEURLOOPSPOORSTAWE EN KLEMPLATE BYGEVOEG GA 22-12-55
WYSIGING 2: DWARSLÊER SPASIËRING DIAGRAM EN SPOORSTAAF LENGTES DIAGRAM UITGEKRAP. WYDTE VAN KLEMPLAAT VAN 2 1/16" TOT 2", EN SLUIT STUK EN TITEL, VERANDER. 23-3-57
WYSIGING 3: LENGTES VAN DEURLOOPSPOORSTAWE VAN 28'-0" TOT 27'-0" VERANDER, SPLITSPOORSTAAF VAN 22'-0" TOT 21'-4½", EN TOTALE LENGTE VAN 37'-9" TOT 36'-1½" VERMINDER. SPOORSTAAF SNY-DIAGRAMME EN IDENTIFIKASIE MERKING BYGEVOEG
WYSIGING 4. KANTING VAN SKAAFWIG NA 1:25 VERMINDER EN DIK END VAN SKAAFWIG VAN 1 1/16" MAK. TOT 1" VERANDER 20/11/57
S.A.R.
96 lb S.A.R. TRACK
BI-DIRECTIONAL SPLICE JOINT WITH ± 3" MOVEMENT.
SCALES AS NOTED
S.A.S
96 lb S.A.S SPOORLYN
TWEERIGTING-SPLITLAS MET ± 3" SPELING.
SKALE: SOOS AANGEDUI
DRAWN GETEKEN H.B.
TRACED NAGETREK H.B.
CHECKED NAGESIEN R.F.
CIVIL ENGINEER STRUCTURAL & TRACK
SIVIELE INGENIEUR BOUKUNDIG EN SPOORBAAN
CHIEF CIVIL ENGINEER
SIVIELE HOOFINGENIEUR
FILE Nº M 989/3/1 LÊER Nº
DATE 14-9-1954 DATUM
Nº TYPE/TIPE E 3099
AMENDMENTS WYSIGINGS 1 2 3 4

ANNEXURE N° 1*i*.



Berg - Oxelosunds Ry. : Anticreep device. Paulus - Krupp system.

ANNEXURE N° 2.



RAILWAY ORGANISATION	A		B		C		D		E	
	Ft Ins	Metres	Ft Ins	Metres	Ft Ins	Metres	Ft Ins	Metres	Ft Ins	Metres
SOUTH AFRICAN RAILWAYS	16 – 0	4 88	9 – 0	2 06	1 – 6	0 46	0 – 3	0 08	2 – 4	0·71
AUSTRALIAN RAILWAYS	22 – 0	6·71	11 – 8	3 56	1 – 5	0 43	0 – 0·	0 0	3 – 0	0 91
SWEDISH RAILWAYS	18 – 4	5 60	10 – 10	3 30	2 – 0	0 60	0 – 47	0 12	0 – 98	0 25

Comparative international ballast and formation diagram.

[621 .139, 625 .18 & 625 .27]

On the value acquired by stocks of « bulk materials » according to their « law of movement »,

by Dr. Eng. Calogero MUSCIA.

(*Ingegneria Ferroviaria*, No. 5, May 1957.)

SUMMARY

The stores stock of materials held by large industrial undertakings form a financial burden which grows according to their size. Railway undertakings, from their very nature and social functions, require large quantities of supplies which result in heavy financial charges where the stocks are not rapidly consumed. The calculation of accrued interest, moment by moment, is not easy, and has led to the introduction of a law, $\mu(t)$, of stock movement relative to time, and the present article will examine different forms of this function. If this function is linear for materials consumed within a period of a few months, or alternative and if a keen price has been obtained and, by means of « open contracts », real competition between a number of traders has been established, then the charge on the undertaking, at least for « bulk » materials (that is to say, for materials which are used frequently and in large quantities) can be contained within fairly narrow limits.

1. — The materials in stock in the stores of a large industrial undertaking, considered by themselves, and not a part of the general assets of the undertaking — because if they are used they constitute, as a part of their specific function, a factor in the general productivity — result in the tying up of heavy capital sums. These sums, if employed elsewhere, might show very rapid tangible returns, but they are imprisoned within the walls of enormous warehouses in the form of materials which, although indispensable to the conduct of the undertaking, being not immediately put to use, attract to themselves an economic burden which grows steadily with the passage of time.

The profit which the same sum invested in a « live » part of the undertaking would bring in is not only not realisable but, in addition, the undertaking is subjected to other burdens by the necessity of establishing a complex stores organisation. These are by no means negligible, and arise from the necessity to acquire land and construct and equip suitable buildings, and from the employment of special staff for storing, issuing, accounting and surveillance.

The optimum or ideal limit would obviously be to abstain from holding any stocks whatever, and to be able to buy whatever is required direct from the producers as and when the need for their immediate use appeared. This, of course, is what the small artisan generally does (unless there are special circumstances) when he buys his materials as required for his job. But the larger, the more complex, the more highly capitalised, and the more specialised the undertaking, the further it is driven away from this ideal, and the more, therefore, is it bound to allocate sufficient capital to its stocks of material. Railway undertakings in particular are forced into this position because of the importance of their services and because of the specialised nature of their fixed installations and rolling stock.

Calculations will quickly show the size of the problem involved. A stores stock of 50 000 million lire (a stock which is very modest for a reasonably sized railway) burdened with normal interest, i.e. one of

5 % plus a constant 1.5 % for stores handling and administration will result, if it remains *invariable,* i.e. without new purchases or deductions; at the end of a month, in a charge of 272 million lire, at the end of six months in 1 655 million lire, and at the end of a year in 3 287 million lire and so on, following an exponential law, always assuming that prices and the value of money remain constant. The *average* value of these charges during the course of the first year will oscillate around 1 555 million lire.

From this, it can be seen why management is very concerned both to limit the total stock by holding in their own stores as far as possible only those articles which are either specialised or difficult to obtain on the open market and, on the other hand, to review constantly the issues, stock levels and purchases in order to avoid holding any quantity of « dead stock ». Thus, they attempt, as regards purchasing, to place orders in conditions as near as possible to the « optimum » which has been mentioned above, i.e. to acquire their materials in a number of small batches depending on the consumption, so as to ensure that the stock is turned over in a reasonable time. This makes it possible to profit doubly by the realisation of the assets by their use, and by the limitation of the capital tied up in inactive stocks.

On the other hand, as a general rule, a great variety of materials can be acquired from the open market on demand whenever the necessity occurs — such as commercial bars and sections of steel, common timber, nuts, bolts, screws, etc.

Managements are also turning their attention to the stores organisation itself in order to rationalise the installations and equipment and to mechanise, as far as possible, the distribution of materials, taking into account, of course, the geographical disposition of the using departments. They are also tending to mechanise the accounting procedures and to improve, in all other ways, the staff utilisation and administrative methods.

2. — The analytical calculation of the charges on the capital invested in a collection of stores stocks or, in other words, of the « acquired value » of them (basing the figures on « unit capital » corresponding to « unit stock ») is not as simple as would appear at first sight.

Both in general, and in the case of railway undertakings in particular, the raw materials and manufactured items are in great variety and have widely fluctuating rates of delivery and issue, and thus present laws of movement of great diversity. Moreover, they are seldom regular over a long period of time.

The stores will usually have in stock both « finished » and « unfinished » articles of some tens of thousands of items, and even if one could determine, at the cost of a great deal of labour, the actual quantities of each type in stock at a given moment, it is extremely difficult to determine after the event, for the purpose of these calculations, the exact moment when each article in the stores was taken into stock — which is, of course, the moment from which interest charges on it start to accrue. The same applies to its issue, from which moment interest ceases to be payable.

In consequence, if average figures of stock holdings are used to calculate the financial charges, considerable error is likely to arise because no account is taken of the statistics of stock fluctuation. It is this statistical law, moreover, which should particularly help in achieving the principal aim, which is the reduction of the charges.

This article attempts to make a contribution to methods of calculating these interest charges, while confining itself entirely to items which come within the definition of « bulk materials », in other words, which are delivered to and issued from the stores at frequent intervals and in large quantities. In these cases the « law of movement » can be expressed as a very reasonable approximation to a continuous function of time, t, $\mu(t)$, which is zero when there is no movement.

It is not difficult to define the law of

movement by careful investigation of the relevant statistics of deliveries and issues, and thus one can establish a continuous curve as a function of time. From the curve, the form of the function $\mu(t)$ can be determined, care being taken to avoid complexity in its analytical expression.

A railway undertaking, for example, uses a very large and varied range of materials; it is sufficient to cite that apart from nuts, bolts, screws, commercial sections and the various ferrous and non-ferrous metals, as also brake blocks, sleepers and the rails themselves, the consumption of which remains more or less constant, there are also fish-plates, paper, textiles and coal, fuel oils and lubricants, of which the last three have a very considerable effect on the overall size of the stock.

It may be added that an intermittent phenomenon such as deliveries and issues of stores material can be considered as a continuous process by virtue of the quantities brought into play. This is common practice in analysis. For example, the actuarial function for life expectancy at a given age x, l_x, which is obtained from statistics, is considered as a continuous function and thus can be used for calculation of life assurance premiums although, of course, « life » is not a continuous process. The pattern of births and deaths is, however, a continuous one.

It is also necessary for this law of movement or statistical function that at the time $t = 0$ it will be such that the capital invested in the stock and which, as has already been described, represents the volume in stock, corresponds to an initial capital which will be described as C_0.

In these conditions, if $C_0 = 1$, the capital, C, at a time t, will be the « acquired value » of unit capital, i.e. the sum of unit capital and the interest accrued at the end of the interval of time under consideration.

The calculations will be made without taking into account the monetary system, and it will be assumed, for the sake of simplicity, that monetary devaluation does not enter into the picture, at least within the limits of time being considered.

3. — If δ is the « instantaneous capitalisation rate » — that is to say, the nominal annual rate convertible moment by moment (1) corresponding to an effective annual compound interest rate i_1, one obtains, as is well known (2) :

$$\delta = ln\,(1 + i_1).$$

It may be added that it will be useful for the succeeding calculations that the nominal convertible rate twelve times a year corresponding to the effective annual rate of i_1 % has a value of :

$$\underset{(12)}{i_1} = (1 + i_1)^{\frac{1}{12}} - 1 .$$

When $i_1 = 5$ %, then $i_1\,(12) =$ approximately 0.0042, which will thus be the monthly rate equivalent to an annual compound interest rate of 5 %.

The instantaneous capitalisation rate at simple interest for an annual rate i_2 is given, as is equally well known, by the formula :

$$\delta\ (t) = \frac{i_2}{1 + i_2 t},$$

and in this case, of course :

$$\underset{(12)}{i_2} = \frac{i_2}{12}.$$

In these calculations, account must be taken of either one or other of these systems of capitalisation.

If, in fact, the same capital C_0, at present invested in stocks, had been put on deposit, it would have produced an annual com-

(1) Which is the same as saying that at any instant the interest accruing is added to the capital to produce new interest.

(2) See, for example, R. CULTRERA, *Lezioni di Matematica Attuariale* (Lessons in Actuarial Mathematics), Libraria Eredi Virgilio Veschi, Rome (1953).

pound interest i_1, whereas the whole stores organisation, which has been discussed above, produces a further charge on the undertaking equivalent to a rate of simple interest i_2, which has a greater or smaller value in proportion to the measures that have been taken for rationalising the administrative operations.

It is not likely that in practice i_2 will be very far from 1.5 %, and in this case, therefore, $\underset{(12)}{i_2} = 0.00125$.

The calculations will be based on an annual compound interest rate i_1 of 5 %, and an annual simple interest rate, i_2, of 1.5 %.

In consequence, the equation which shows the increase of capital C, in an infinitely small portion of time dt, $\mu(t)$ being the function which expresses the law of movement of stock, can be written in the form :

$$dC = C\,[1 - \mu(t)]\,[\ln(1 + i_1) + \frac{i_2}{1 + i_2 t}]\,dt. \qquad (1)$$

If this is integrated for the whole time interval between the limits o and t, it becomes :

$$\ln C = \int_0^t [1 - \mu(t)]\ln(1 + i_1)\,dt + \int_0^t \frac{i_2\,[1 - \mu(t)]\,dt}{1 + i_2 t} + \text{const.} \qquad (2)$$

thence :

$$\int_0^t [1 - \mu(t)]\ln(1 + i_1)\,dt = \ln(1 + i_1)\,[t - \int_0^t \mu(t)\,dt] = \ln(1 + i_1)^{t - \int_0^t \mu(t)\,dt};$$

$$\int_0^t \frac{[1 - \mu(t)]\,i_2}{1 + i_2 t}\,dt = [1 - \mu(t)]\ln(1 + i_2 t) + \int_0^t \mu'(t)\ln(1 + i_2 t)\,dt = \ln(1 + i_2 t)^{1 - \mu(t)} + \int_0^t \mu'(t)\ln(1 + i_2 t)\,dt,$$

so that going back to equation (2) and determining from it the integration constant in such a manner that when $t = 0$, then $C = C_0$, it becomes :

$$\ln\frac{C}{C_0} = \ln(1 + i_1)^{t - \int_0^t \mu(t)\,dt} + \ln + (1 + i_2 t)^{t - \mu(t)} + \int_0^t \mu'(t)\ln(1 + i_2 t)\,dt,$$

or again :

$$C = C_0\,e^{\int_0^t \mu'(t)\ln(1 + i_2 t)\,dt} \cdot (1 + i_1)^{t - \int_0^t \mu(t)dt} \cdot (1 + i_2 t)^{1 - \mu(t)}.$$

If $C_0 = 1$, C will be the value M acquired by this unit capital, and may be expressed as :

$$M = e^{\int_0^t \mu'(t)\ln(1 + i_2 t)\,dt} \cdot (1 + i_1)^{t - \int_0^t \mu(t)dt} \cdot (1 + i_2 t)^{1 - \mu(t)} \qquad (3)$$

which is the general expression which will be used from now on.

It should be noted straight away that when $t = 0$ and on the assumption that $\mu(t)$ is also continuous at this point, one obviously obtains $M = 1$ and, moreover, what is equally obvious, $M = 1$ if $i_1 = i_2 = 0$.

In the absence of capital movement, that is to say, movement of stock in stores, $\mu(t) = 0$, hence the relation :

$$M = (1 + i_1)^t \cdot (1 + i_2 t) \qquad (4)$$
$$[\mu(t) = 0]$$

which is the expression normally used for quick calculations but which, if not coupled with a more general expression, taking account of stock movement, can only produce relatively inaccurate results which give average values of the acquired value which are often far removed from reality.

Where $\mu(t) = 1$, this corresponds to the optimum situation for the undertaking because it can be shown from equation (3) that :

$$M = 1 ,$$

i.e., that there is theoretically no interest charge at all to be borne.

The investigation by analytical means into the average value in a given time t_0 of the principal expression (3) is not, in general, easy, and makes recourse to approximations inevitable. It is better, therefore, as will be done in the example to follow, to effect the integration graphically, after having plotted, as accurately as possible, the curve representing M.

4. — The two cases for $\mu(t)$, which will be considered below must be regarded as particular examples. In practice, it will follow a determined law, function of time. We take for examples :

a) Suppose that from the data given the relation :

$$\mu(t) = kt ,$$

has been obtained, or, in other words, $\mu(t)$ is a linear function of time, k being the coefficient of the angle between the straight line joining the ordinate (unit capital) to a point t_0 of the abscissa. Then if we assume that, for example, a unit of stock is consumed in one year, then :

$$t_0 = 12, \text{ and } k = 1/12 = 0.0833.$$

Equation (3) then gives :

$$M = e^{-kt} \cdot (1 + i_1)^{t - \frac{kt^2}{2}} \cdot (1 + i_2 t)^{\frac{k + i_2}{i_2}} \quad (5)$$

$[\mu(t) = kt]$

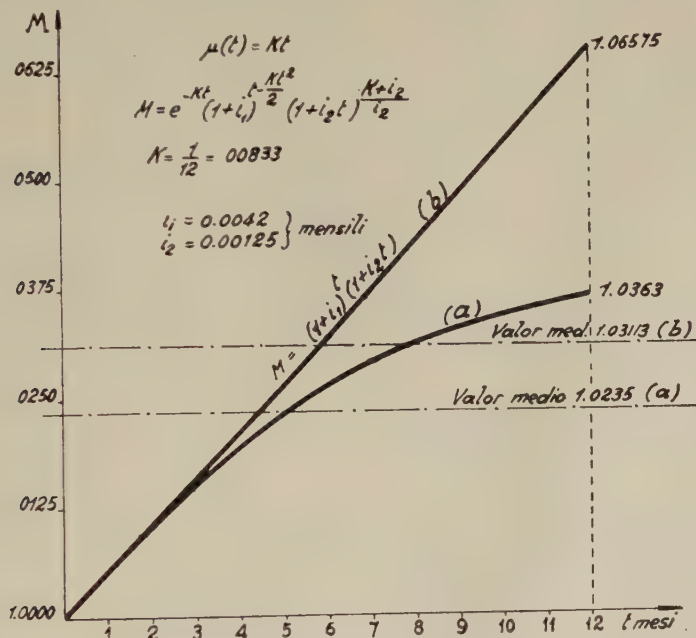


Fig. 1. — *a*) Value acquired by a unit of capital with a linear consumption function $k = 0.08333$, corresponding to the consumption of a unit of stock during one year; *b*) The value acquired by comparison where : $M = (1 + i_1)^t . (1 + i_2 t)$ for a unit of stock which does not move. ($i_1 = 0.0042$, $i_2 = 0.00125$ monthly).

N. B. — Mesi = month. — Mensili = monthly. — Valor-medio = average value.

The curve representing this expression has been plotted in figure 1(*a*) and, by way of comparison, curve *b*) has also been plotted showing equation (4). The average value acquired by a unit of capital is shown to be 1.0235 instead of 1.0311, $t = \pi$, $\mu = -1$. When t is $\frac{3\pi}{2}$, $u = 0$, and when $t = 2\pi$, $\mu = 1$.

The effect is therefore of an alternate rise and reversal as a unit of stock is replaced.

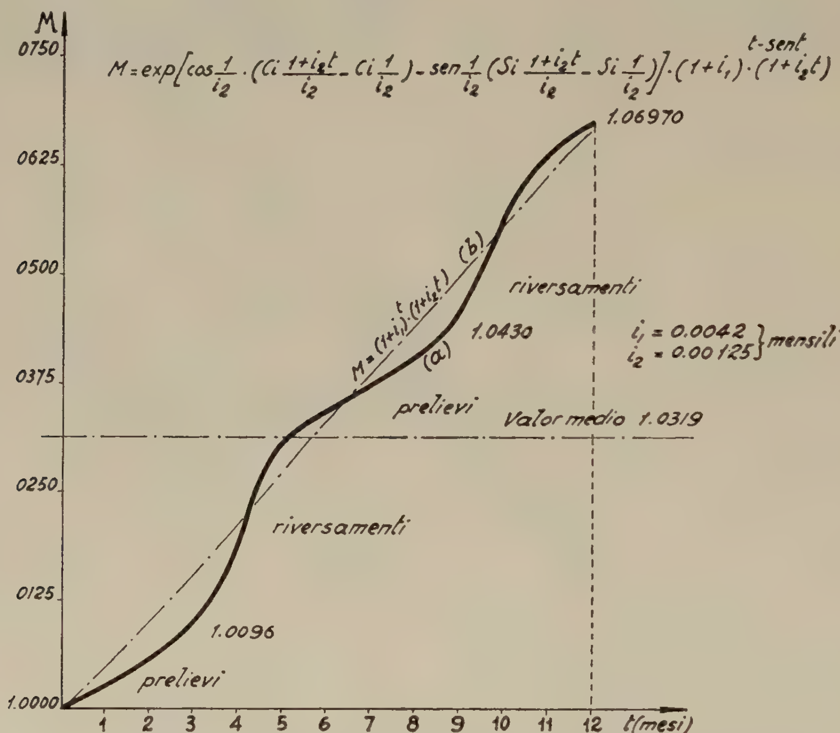


Fig. 2. — *a*) Value acquired by a unit of capital where the movement function of the stock $\mu(t) = \cos t$, corresponding, in a period of one year, to a complete consumption and replacement of the stock; *b*) Comparison with the value acquired when $\mu(t) = 0$.

N. B. — Mesi = month. — Mensili = monthly. — Valor medio = average value. — Prelievi = issues. Riversamenti = replacements. — Sen = sin.

as in the case of stock in which there is no movement.

The error resulting, for the sake of simplicity, from the use of equation (4) instead of equation (5), would therefore be 0.76 %.

b) Assuming that the function $\mu(t)$ is cosinusoidal or, in other words, that $\mu(t) = \cos t$, then when $t = 0$, $\mu = 1$, and cyclically when $t = \frac{\pi}{2}$, $\mu = 0$, and when

If μt is substituted in equation (3) one obtains, after simple resolution :

$$\mathrm{M} = \exp\left[\cos\frac{1}{i_2}\left(\mathrm{Ci}\,\frac{1+i_2t}{i_2} - \mathrm{Ci}\,\frac{1}{i_2}\right)\right.$$

$[\mu(t) = \cos t]$

$$\left. - \sin\frac{1}{i_2}\left(\mathrm{Si}\,\frac{1+i_2t}{i_2} - \mathrm{Si}\,\frac{1}{i_2}\right)\right]$$

$$\cdot\,(1+i_1)^{t\sin t}\cdot(1+i_2t)\,, \qquad (6)$$

in which Ci and Si are respectively the known functions of the integral cosine and integral sine which are given in numerous treatises (3).

Figure 2 shows equation 6 graphically. The variation in the acquired value with time at first falls (as material is issued from stores) and then increases (as material is repurchased) and so alternating with a decreasing periodicity and amplitude. The value acquired at the end of the year is comparable with that resulting from the use of equation (4), which is shown in the figure by way of comparison.

5. — Equation (3) must be considered from the analytical viewpoint as the functional equation M $[\mu(t)]$; for each function $\mu(t)$ the expression (3) has different variations as t varies or, in other words, it forms a family of curves. It would be interesting theoretically to attempt to find the limiting curve, and for this purpose it is useful to use the variation calculations.

It is necessary to have the expression :

$$\int_0^t \delta\, \mathrm{M}\,(\mu',\ \mu,\ t) = 0\ ,$$

which, developed, leads to Euler's equation :

$$\frac{\partial^2 \mathrm{M}}{\partial \mu'\ \partial \mu'}\,\mu'' + \frac{\partial^2 \mathrm{M}}{\partial \mu\ \partial \mu'}\,\mu'$$

$$+ \frac{\partial^2 \mathrm{M}}{\partial t\ \partial \mu'} - \frac{\partial\, \mathrm{M}}{\partial \mu} = 0\,.$$

In this case, applying it to (3) :

$$\mu'' - \frac{ln\,(1+i_1)^t}{ln\,(1+i_2t)\,\overline{\dfrac{i_2t+1}{i_2}} - t}\,\mu'$$

$$+ \frac{ln\,(1+i_1) + \dfrac{i_2}{1+i_2t}}{ln\,(1+i_2t)\,\overline{\dfrac{i_2t+1}{i_2}} - t}\,(1-\mu)$$

$$+ \frac{ln\,[(1+i_1)^t \cdot (1+i_2t)^2]}{[ln\,(1+i_2t)\,\overline{\dfrac{i_2t+1}{i_2}} - t]^2} = 0\,, \qquad (7)$$

an equation which is of the form :

$$\mu'' + f\,(t)\,\mu' + g(t)\,\mu = h(t) \qquad (8)$$

of which the general integral is (4) :

$$\mu = \mathrm{C}_1\varphi + \mathrm{C}_2\varphi\int \frac{dt}{\mathrm{E}\varphi^2}$$

$$+ \varphi\int\frac{1}{\mathrm{E}\varphi^2}\Big[\int \mathrm{E}\varphi h\ dt\Big]\,dt\,, \qquad (9)$$

with φ a particular solution of (8) made whole :

$$\mathrm{E}\,(t) = \exp \int f\,(t)\,dt$$

and C_1 and C_2 are the integration constants corresponding to the conditions imposed for $\mu(t)$.

Apart from the obvious difficulties in finding the solutions of (7), it must be remembered that in the question under consideration theoretical solutions are not of great interest as the results required must correspond to what is found in practice.

For this problem, the practical limit of the family of curves of function M must be that function which results in the value of a unit of capital remaining constant with time, i.e. which counteracts exactly the results of accruing interest. Thus, if μ is constant and equal to 1, then it can be seen from equation (3) that M = 1 at any point of time, but in these conditions, as can be seen from equation (7) :

$$(1+i_1)^t = (1+i_2t)^{-2}$$

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(3) See, for example, JAHNKE-ENDE : *Tafeln höherer Functionen* (Tables of higher functions), B.G. Teubner Verlagsgesellschaft, Leipzig, 1952. Where $i_2 = 0.00125$, then $1/i_2 = 800$, C$i\,\dfrac{1}{i_2} =$ 0.00118, Si $1/i_2 = 1.5714$, and Ci 900 = 0.001109, Si 900 = 1.5707.

(4) Cf. for example, E. KAMKE, *Differentialgleichungen, Lösungsmethoden und Lösungen* (Differential equations, methods of solution and solutions), Akademische Verlagsgesellschaft, Geest & Portig, Leipzig (1956).

which is true when :

$$i_1 = \frac{1}{(1 + i_2 t)^{\frac{2}{t}}} - 1 ,$$

or again :

$$i_2 = \frac{1}{t\,(1 + i_1)^{\frac{t}{2}}} - \frac{1}{t} ,$$

or, in other words, if $i_1 = i_2 = 0$ (an academic case) or if i_1 and i_2 are negative rates of interest, which is hardly admissible.

On the other hand, it can be shown from equation (4) that when $M = 1$:

$$i_1 = \frac{1}{(1 + i_2 t)^{\frac{1}{t}}} - 1 ,$$

or :

$$i_2 = \frac{1}{t\,(1 + i_1)^{t}} - \frac{1}{t} .$$

which are equally unacceptable results.

By analytical methods, therefore, one cannot obtain the limits of M which are realisable in practice. In these conditions, it is preferable to attempt expressions for $\mu(t)$ such that when substituted into equation (3), they give rise to the most suitable « acquired values ».

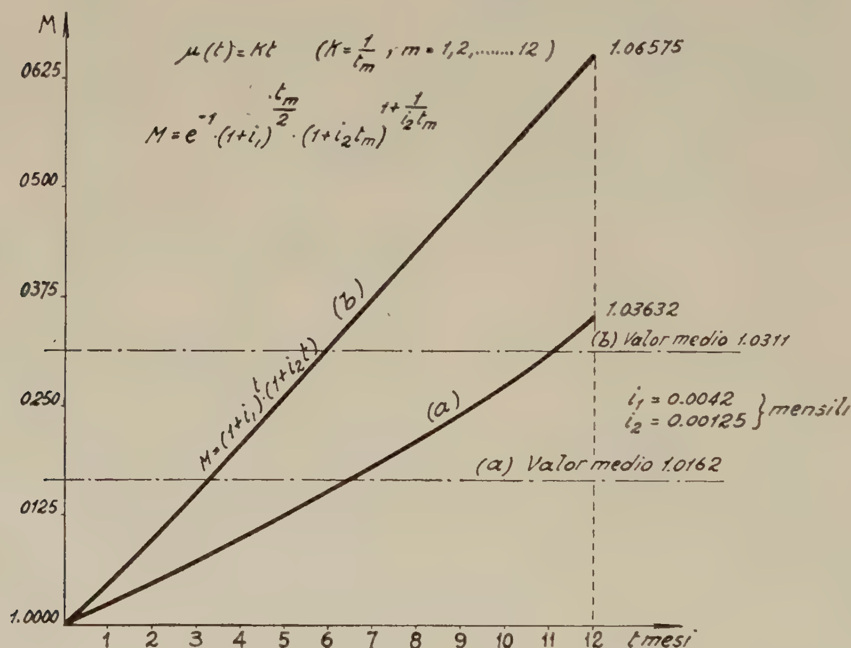

Fig. 3. — *a*) Value acquired by a unit of capital :

$$M = e^{-1}\,(1 + i_1)^{\frac{t_m}{2}}\,(1 + i_2 t_m)^{1 + \frac{1}{i_2 t_m}}$$

with a movement function : $\mu = kt$, and $k = \frac{1}{t_m}$ $(m = 1, 2, ..., 12)$, typical of certain open contracts; *b*) Comparison with the value : $M = (1 + i_1)^t \cdot (1 + i_2 t)$ acquired by a unit of capital where no movement occurs during the year.

a) For example, supposing :

$$\mu(t) = kt \qquad (10)$$

but with the assumption that k is not constant. If the year is divided into months t_1, t_2, ... t_{12} then, in a general manner, t_m, k represents the angular coefficient of the straight line on a graph joining the

If therefore, it is assumed that $k = \frac{1}{t_m}$ it can be seen from equation (5) :

$$M = e^{-1}(1 + i_1)^{\frac{tm}{2}} \cdot (1 + i_2 t_m)^{1 + \frac{1}{i_2 t_m}}$$

$$[\mu(t) = \frac{t}{t_m}] \qquad (11)$$

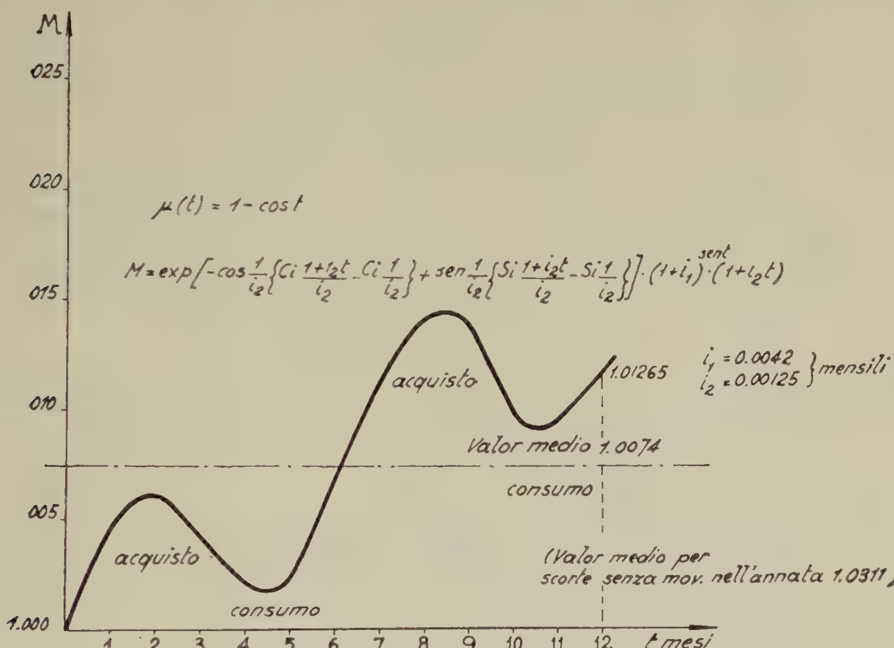

Fig. 4. — Value acquired by a unit of capital with a movement function corresponding to successive consumptions and replacements of the stock in a year. Typical of certain open contracts.

N. B. — Consumo = consumption. — Acquisto = purchase. — Valor medio per scorte... = average value for stocks where no movement occurs during the year.

origin to the value of a unit of capital at a time t_m. In other words, the units of stock acquired during one month would be linearly consumed in one month, the units of stock acquired over two months would be similarly linearly consumed in two months, and similarly the units of stock acquired during a time t_m would be evenly consumed during the same time t_m.

Figure 3 shows graphically the calculated acquired value and compares it with the total of units of capital in the case where no movement has taken place during the year. The low value of the interest month by month, as also the low average value for the year 1.0162 compared with 1.0311 for the fixed capital will be noticed.

b) There is, however, another movement

function, $\mu(t) = 1 - \cos t$. From equation (3) one obtains :

$$M = \exp\left[-\cos\frac{1}{i_2}\left(\mathrm{Ci}\,\frac{1+i_2t}{i_2} - \mathrm{Ci}\frac{1}{i_2}\right) + \sin\frac{1}{i_2}\left(\mathrm{Si}\,\frac{1+i_2t}{i_2} - \mathrm{Si}\frac{1}{i_2}\right)\right](1+i_1)^{\sin t}\cdot(1+i_2t),$$

stock is consumed in the year according to a linear law. By way of comparison, the acquired value corresponding to each of the two functions $\mu(t) = kt$ and $\mu(t) = 1 - \cos t$ are illustrated on figure 5 on the same scale.

6. — The cases of stock movements discussed above, that is to say :

$$\mu(t) = kt \quad \text{with } k = \frac{1}{t_m},$$

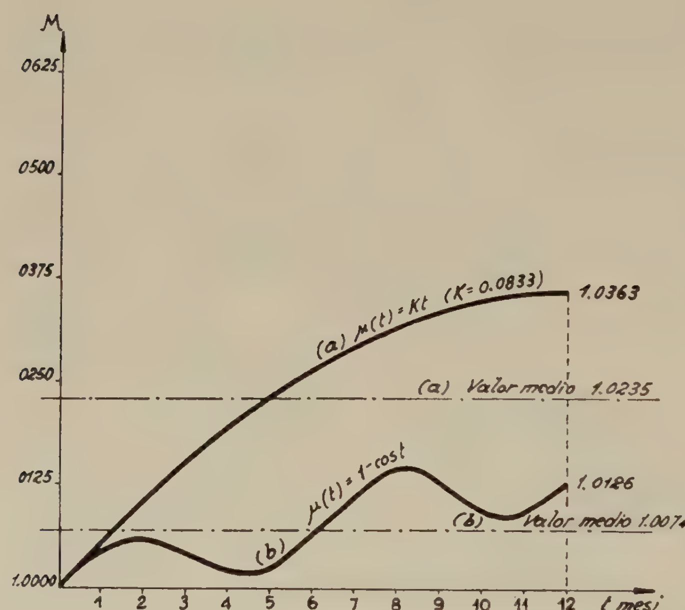

Fig. 5. — Comparison of the values acquired by a unit of capital : *a*) for stocks bought in yearly quantities which are consumed during a year : $\mu(t) = kt$; *b*) for stocks bought and consumed at intervals during the year : $\mu(t) = 1 - \cos t$.

C*i* and S*i* being again the integral cosine and integral sine respectively. The total has been shown in the graph in figure 4.

The low value of the resulting interest will again be noted.

The average value for the year is barely 1.0074 against 1.0311 found in the case of stock which does not move and 1.0235 in the case (fig. 1) in which the unit of

and :

$$\mu(t) = 1 - \cos t$$

are typical of so-called « open contract » purchasing. By force of competition, an agreement is made with the trader for a given period to supply fixed quantities of bulk materials at stated intervals in accordance with foreseeable needs.

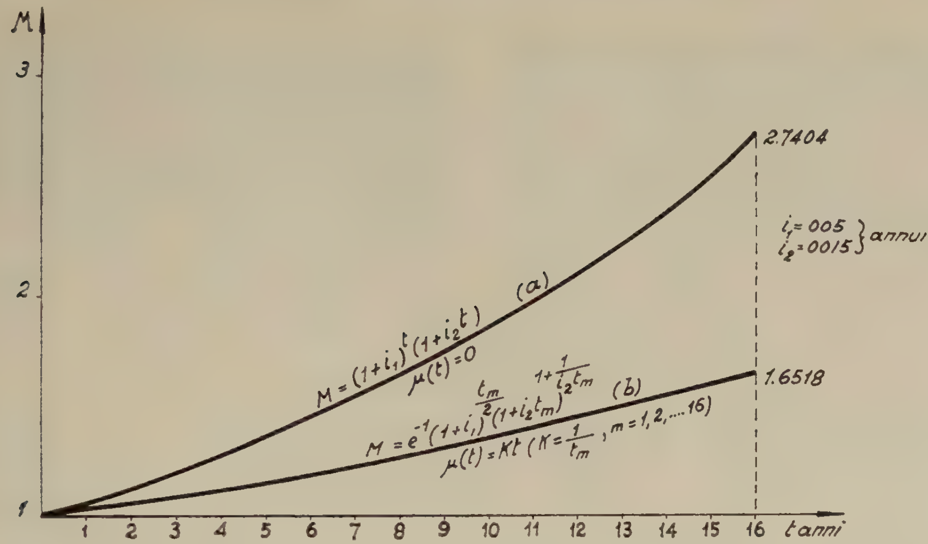

Fig. 6. — Comparison between the values acquired for stocks without any movement $\mu(t) = 0$, and stocks with a movement function $\mu(t) = kt$, $(k = \frac{1}{t_m})$.

TABLE 1. — **Values acquired month by month by a capital of 100 units for movement functions**

$$\mu(t) = 1 - \cos t\,;\quad \mu(t) = kt\,,\ \text{with}\ k = \frac{1}{t_m}\,;$$

$$\mu(t) = kt\,,\ (k = 0.0833)\,;\quad \mu(t) = \cos t\,;\quad \mu(t) = 0.$$

Months	$\mu(t) = 1 - \cos t$	$\mu(t) = kt$, $k = \frac{1}{t_m} (m = 1,2,...12)$	$\mu(t) = kt$, $k = \frac{1}{12} = 0.0833$	$\mu(t) = \cos t$	$\mu(t) = 0$
0	100.00	100.00	100.00	100.00	100.00
1	100.47	100.15	100.53	100.34	100.54
2	100.62	100.49	101.05	100.70	101.09
3	100.43	100.83	101.65	100.96	101.64
4	100.22	101.10	101.94	101.16	102.20
5	100.21	101.37	102.32	103.16	102.75
6	100.73	101.63	102.64	103.43	103.31
7	101.13	101.97	102.88	103.59	108.87
8	101.42	102.21	103.15	104.01	104.44
9	101.39	102.38	103.34	104.51	105.01
10	100.95	102.75	103.48	105.82	105.59
11	100.94	102.99	103.58	106.60	106.24
12	101.26	103.46	103.63	106.97	106.57
Average value	100.74	101.62	102.35	103.19	103.11

TABLE 2. — **Values acquired yearly by a capital of 100 units for movement functions**

$$\mu\,(t) = kt, \left(k = \frac{1}{t_m}\right), \text{ and } \mu(t) \doteq 0,$$

for a period of 16 years.

Years	$\mu(t) = kt, \left(k = \frac{1}{t_m}\right)$	$\mu(t) = 0$
0	100.00	100.00
1	103.63	106.57
2	106.26	113.50
3	109.80	120.90
4	113.14	129.00
5	116.85	137.17
6	120.66	146.06
7	124.66	155.58
8	128.08	165.64
9	131.49	176.03
10	135.70	187.45
11	141.73	199.21
12	144.48	212.40
13	150.28	225.25
14	155.44	239.58
15	160.61	254.80
16	165.18	274.04

This form of contract is attrative to both parties. The supplier obtains a virtually guaranteed quantity of work without an absolute undertaking being given by the buyer while, on the other hand, the buyer is able to dispense with the necessity of holding large stocks of consumable material against requirements spread over a possibly lengthy period, at the price of considerable interest charges. He is also able to reduce his administrative work because he may obtain his deliveries by a simple « request for delivery under contract » instead of going through the complete ordering procedure, and this equally results in simplification of the associated accounting work.

On the other hand, the purchaser must exercise the greatest care in examining contract prices, taking account of the theoretically calculated average values, in order to avoid the natural tendency of the trader to include in the price to be paid a sum to cover the interest charges which the purchaser is trying to avoid. In general, it can be assumed, however, that if the prices are obtained as a result of genuine competition between a number of traders, this fear can be discounted, as it may be presumed that the successful tenderer has covered his risk in his minimum price.

7. — In figure 6, the « acquired values » corresponding to equation (4), « dead stock », and (11), « material consumed during a time $t_m = \frac{1}{k}$ » are shown for a period of 16 years. It can be seen that the capital corresponding to a unit of stock which does not move has a value of 1.3717 at the end of five years, 1.8745 at the end of ten years, and 2.7404 at the end of sixteen years. These figures show just how essential it is for the stores organisation of an undertaking to rid itself of non-moving stocks. It also shows how careful the using departments must be to evaluate the real cost of excessive caution when, for reasons of possible later usefulness, they will not agree to release materials which, even if disposed of at much reduced prices, could become a source of revenue rather than a charge upon the undertaking's resources.

In tables 1 and 2 are shown numerical values (based on an initial capital of 100 units) of each of the movement functions examined above, compared with those of zero movement, as also the annual totals, for a period of sixteen years, corresponding to the movement function :

$$\mu(t) = kt\,, \left(k = \frac{1}{t_m}\right)$$

and $\mu(t) = 0$ (zero movement).

8. — The study made above has shown how important it is to take into consideration the law of stock movement, so as to be able to determine realistically the charges bearing on an industrial undertaking from its need to hold stocks of material. The greater the stocks, the heavier the charges and the more necessary it is (as in a railway

undertaking) for the supplies department not only to follow the market, to buy at the most opportune moment, to « pare » prices and to watch over the general administrative efficiency of their organisation, but also to pay particular attention to the size of their stocks. They must, also, study the laws of movement, and restrain, where necessary, requests to hold stocks originating in the using departments, as the latter are by nature inclined to play safe rather than adopt means which might appear to be financially advantageous. Finally, every possible expedient must be used to ensure that the capital tied up in stock is not burdened with excessive charges to the detriment of the undertaking as a whole.

[625 .143 .3]

Is rail corrugation due to internal stresses ?

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I

Some points on normal wear of the running surface.

About three years ago, Mr. John DEARDEN of the British Railways sent us a copy of his paper : The Wear of Steel Rails, a Review of the Factors involved (1) (*), given at a meeting of the Institution of Civil Engineers. Although this paper only deals with normal rail wear, certain passages in it suggested to us that particular statements made by Mr. DEARDEN might apply as well to corrugated as to normal rail wear.

In his investigation Mr. DEARDEN used a « contorograph », a device which records the running surface of the rail with correct horizontal scale but enlarged ten times in vertical scale.

This enlargement enables aspects of wear to be observed which would not have been noticed without it.

It was established for example (p. 460) that the profile of the rail, after reaching a particular worn profile, did not change for about eight years, depending, except in certain circumstances which were discussed later, on the nature of the traffic. With normal wear the profile was reduced slowly, wear taking place vertically and also horizontally under the influence of hunting movement.

It was pointed out (p. 478) that many rails on main lines have a bright band 12-35 mm wide, flanked on each side by bluish grey coloured bands covered with crushed rust.

It appeared that most wheels only touch a narrow band of the running surface. This phenomenon was investigated by covering the running surface with a thin layer of white, quick-drying, paint (see fig. 1). The operation was repeated at a number of places, even where the rails had no bright band.

All these experiments made it appear that about 90 % of the wheels touch the running surface on a band about 25 mm wide. The running surface was only contacted throughout its width after the passage of about 500 wheels.

But despite this heavy use of the centre of the surface it does not wear more quickly than the side bands, which do not, as a rule, make contact with the wheels; as we have said, the profile does not change. *In a given transverse section the wear at a given point of the*

(*) The figures in brackets refer to the numbers in the bibliography given at the end of this article.

running surface is inversely proportional to the number of contacts made by the wheels.

It can be deduced from this that corrosion is entirely responsible for the wear of the two side strips.

As for the rate of wear of the bright strip and that of the side strips, they

After the passage of the number of wheels shown.

Fig. 1.

are probably related one to the other. When one is worn more quickly than the other, the load is concentrated on the latter until equilibrium is established. Thus the wear of the two side strips is governed by that of the centre strip, which is the most heavily used.

During the discussion which followed this paper, Mr. A.K. TERRIS remarked (p. 481) that the author had assumed that wear of the two side strips appeared to be due entirely to corrosion; but he wondered whether it was not possible that this wear might be caused by « fretting corrosion ».

Not being an expert on the subject, but a practical engineer, his attention had been drawn to what he had recently read about the subject.

He thought that this phenomenon might be due, in the circumstances under consideration, to the interaction of wheel and rail.

He supposed that the base metal was oxidised by rubbing, thus forming hard and abrasive particles. He admitted the possibility that these particles were displaced laterally by the movement of the wheels resulting in a certain grinding of the two side strips of the running surface.

He thought it not impossible that the profile of the surface, when ground in this way, remained unchanged despite the light use of the margins and the intensive use of the centre.

No doubt, this factor might to some extent be related to Mr. DEARDEN's suggestion that the running surface of the new rails ought to be designed with a radius of 150 mm.

It appears to us that Mr. TERRIS is correct. There are two kinds of wear on the running surface; wear of the bright strip, as a result of rolling, and wear of the side strips, as a result of rubbing. The latter is the harsher and it appears to us that it increases in a greater proportion than the square of the relative movement. We will give

reasons for this view later. This wear has been the subject of a number of investigations, particularly so far as the relation between the rail and the wheel is concerned, by Prof. Dr. M. FINK (2) and Dr. SPÄTH (3).

In his paper Mr. DEARDEN also made suggestions of this sort, saying that Prof. SPRING had already determined in 1888 that the iron rust Fe_2O_3 was converted under pressure into black magnetic ferrous oxide, formula Fe_3O_4. Dr. BARWELL had doubts on this matter. He thought this was somewhat unlikely since, at that time, there was as yet no X ray apparatus. He stated that there were at least six different modifications of oxides and hydroxides.

Prof. FINK had already referred in 1929 (2) to the Lechatelier principle. He suggested that oxygen in the atmosphere, when compressed in proximity to particles of iron in small cavities, joined with it to form FeO, because the latter is smaller in volume than the separate particles of iron and oxygen.

Curiously enough we use the same principle, but in a reaction in the opposite direction. It does not seem impossible to us that 3 (Fe_2O_3), under pressure may be transformed into 2 (Fe_3O_4), releasing an atom of O. This atom O, being very aggressive, is attracted by Fe particles, which are present in large numbers on the ground strip, and there immediately forms a ferrous oxide.

Prof. FINK said last year that, because of the attraction of atoms of iron, an atomic layer of O formed above the base steel, thus detaching particles of the metal. My hypothesis may perhaps be of a kind which supports this view. But, not being a chemist, I must leave this question for a further consideration.

In any case, the margins of the running surface are worn in this way or another, without being used accordingly.

We are thus forced to find an explanation of this apparently contradictory phe-

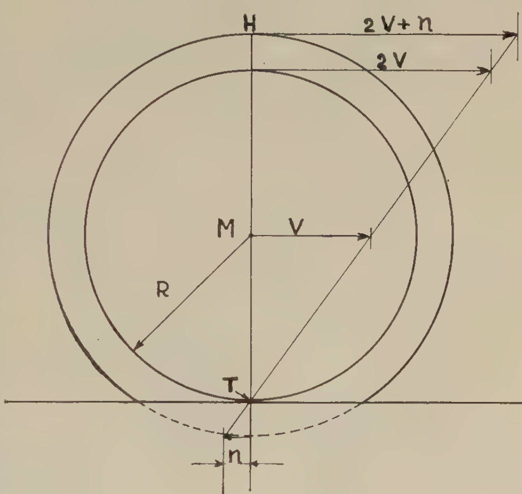


Fig. 2.

nomenon. We think we have found it in the following reasoning.

The parts of a wheel which is travelling at speed V (fig. 2) have different speeds of movement.

The centre M, has a speed V; T, the point in the plane of travel directly below M, rests on the running surface; at this moment its speed is zero (figs. 2 and 3). But the lowest point of the flange has a speed *n* in the *reverse* direction to that of the wheel.

All points of a wheel which are below the centre of the bright strip of the running surface have a similar

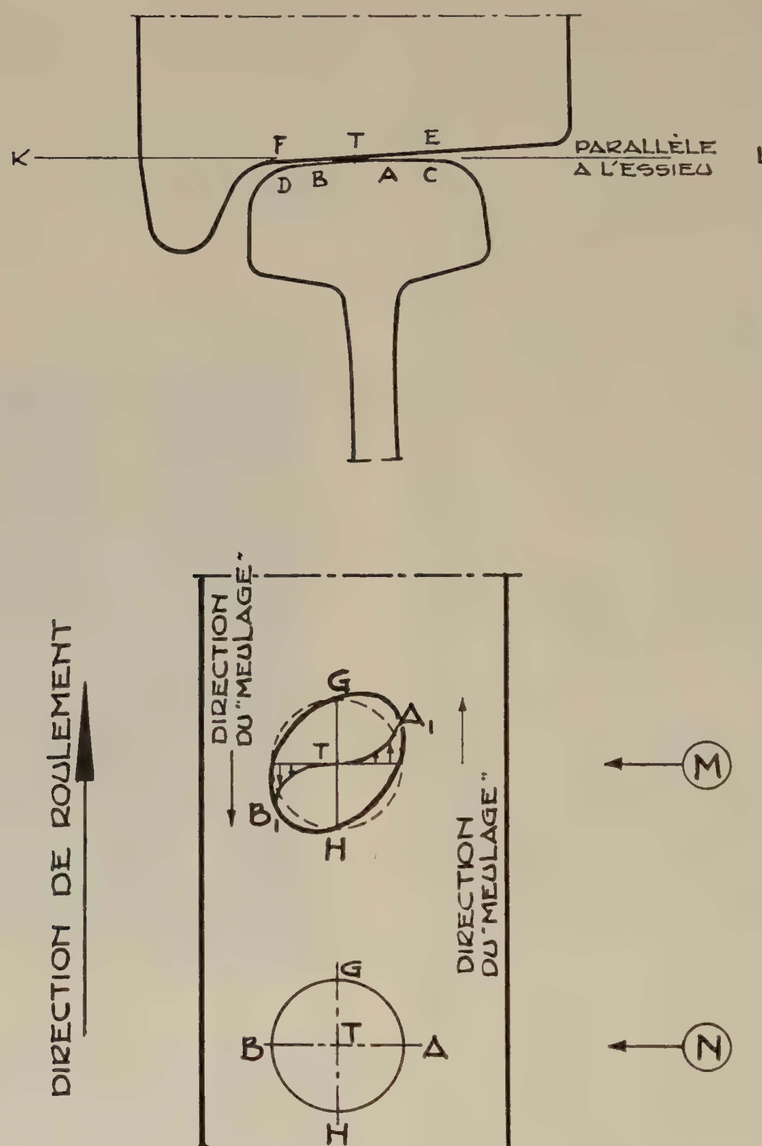


Fig. 3.

Explanation of French terms :

Direction de roulement = running direction. — Direction du meulage = grinding direction. — Parallèle à l'essieu = parallel to the axle.

movement; the points above the centre of this strip have a positive movement. We will discount for the moment the small reciprocal rail/wheel depressions.

Taking a vertical section through the rail at T (fig. 3) the line K-L being parallel to the axle, we see that T-F has a small negative movement, increasing from T to F, and that the section T-E has a small positive movement, increasing from T to E.

The movements between B and A are only very slight. Assuming that the surface N, that is to say the ellipse TAHBG is the rail-wheel contact surface for a stationary wheel placed on the rail, this ellipse of contact changes to M, that is to say TA_1 HB_1 G, through the movement of the axle.

Over the width A-B, we assume that the pressure of the wheel on the rail is large enough and the positive movement of A and the negative movement of B are small enough for them to be absorbed by the elasticity of the steel of the rail and the wheel. This is where the bright strip is formed; there is only rolling wear. But beyond A, in the direction of C, and beyond B, in the direction of D, the pressure decreases while the movement increases. The point E rubs in a positive direction, above the running surface; the point F, on the flange side in a negative direction. This grinding movement also provides an explanation of the recognised obliqueness of the white patches of rail-corrugation.

If we agree that the tyre of the wheel EF is intact and that the running surface is worn to the second-degree curve CABD, we may deduce that wear by rubbing increases in a proportion greater than the square of the relative movement.

The contact surface varies in accordance with the load; that is the breadth of the strip varies directly as the square root of the load.

Now let us consider figure 5. When the load is heavy, the clear strip is A_1-B_1 and the strips exposed to corrosion by rubbing are A_1-C_1 and B_1-D_1.

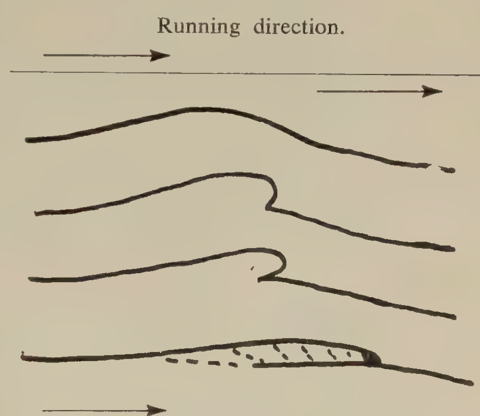


Fig. 4.

Figure 4, taken from *Railway Steel Topics,* shows a simple and enlarged profile of wear by rubbing.

In the case of a light load the clear strip is only A_2-B_2 but the ground and corroded bands are A_2-C_2 and B_2-D_2. This is our explanation of the phenomenon referred to above. As a result, with a given profile, the wear of the running surface can be greater for a light load than for a heavy load.

II

Comparison between normal wear and corrugated wear.

So far we have not referred to corrugation. The whole of Mr. DEARDEN's paper was devoted to normal wear. But

now let us consider figure 6; it shows several rail profiles with different widths of rail head.

The sections marked *c* show the bright strips and those marked *r* the rusted side strips.

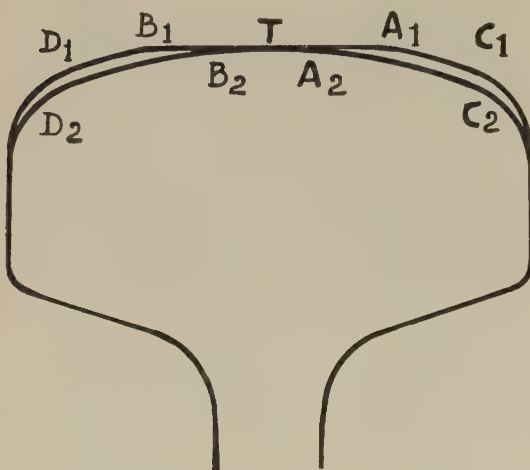


Fig. 5.

Below these profiles we have drawn in a longitudinal section of a corrugated rail. In this way we obtain a similar pattern. Here the *c*'s show the bright high points and the *r*'s the oxidised patches : the depressions. In these two diagrams the surfaces *c* are touched by all wheels but they are not much worn; the surfaces *r* are hardly touched by the wheels but they are worn more than the surfaces *c*.

We wonder whether the same results may not arise from the same cause.

If this is so, it must be that the wheels only touch the high points. Why should all the wheels impinge mainly on the high points ?

Can one conceive of a factor as a result of which all the wheels, of all kinds of vehicles, and of all forms of motive power tend to act in this way ? It seems doubtful.

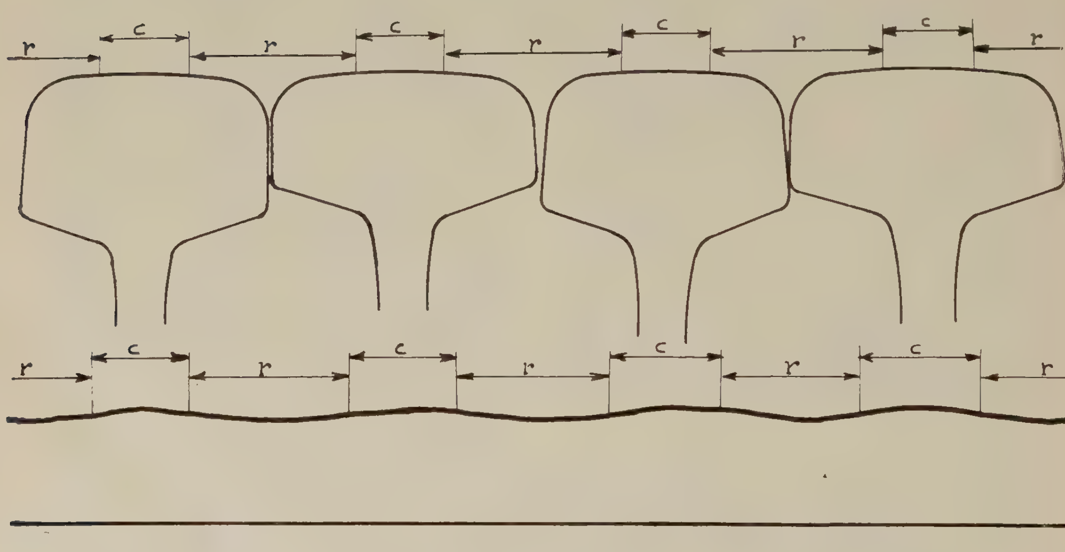


Fig. 6.

The assumption made by Mr. SPADERNA seemed to us acceptable (4) (See also Bulletin for July 1956, p. 649) (5). He suggested that there was a vibration of about 535 c/s in the rail so that the rail knocked against the wheels.

But in our view, this assumption also has disadvantages. It requires, for a given frequency, a particular train speed, a given sleeper-spacing and also a particular moment of inertia of the rail. Moreover a certain vibration of the axle at the top must be in resonance with the dominant frequency of vibration of the rail. For all these reasons, we find the coincidence of all these factors very improbable.

In addition, after consulting other works, it appears that this idea is not new. Thus in a work by Baurat A. MEYER, edited in 1915 (6), we find the following explanation : When a vehicle passes over a joint, it causes the rail to vibrate vertically. As tramway vehicles always run at the same speed at a given point, they pass over each point of the rail when this is in the same phase of vibration. Thus a wheel passing over a rail which is rising causes a depression; a moment later, in the falling phase, a high point is created because the load is decreased.

After taking note of Mr. DEARDEN's findings and in view of our explanation, if it is correct, the opposite would be expected.

Further, in Great Britain, rail vibration had already been under consideration. The remarks made on this subject at a meeting of the « Institution of Civil Engineers » (7) are reproduced hereafter :

« Mr. O'BRIEN observed, that his experience of rail-corrugation was limited to one instance of the phenomenon,

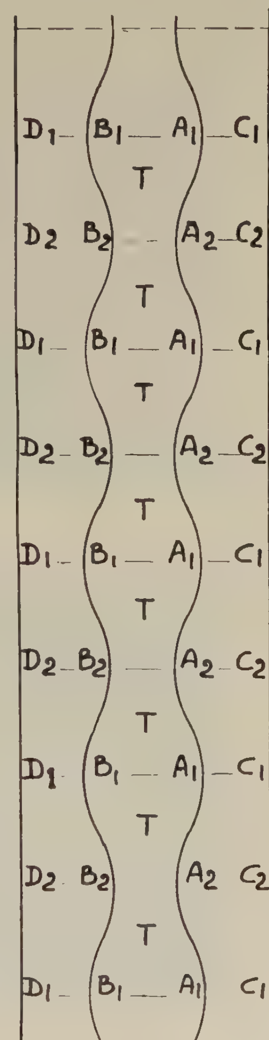


Fig. 7.

which had occurred at a spot on the railway between Liverpool and Southport.

« The corrugation was distinct, but not strongly marked, and extended over about 1/4 mile of track; it had extended in the days of steamhauled traffic, and still existed after 10 years of electrical working.

» In this case, as in many others, the line ran over a bog just at the point where the corrugation occurred. The inconclusive nature of the evidence collected up to the present would lead, by a process of elimination, to the conclusion that corrugation depended on the nature of the true foundation of a railway or tramway, and not merely on the nature of the upper 4 feet or even 10 feet of a roadbed.

» He suggested that a vibratory ac-

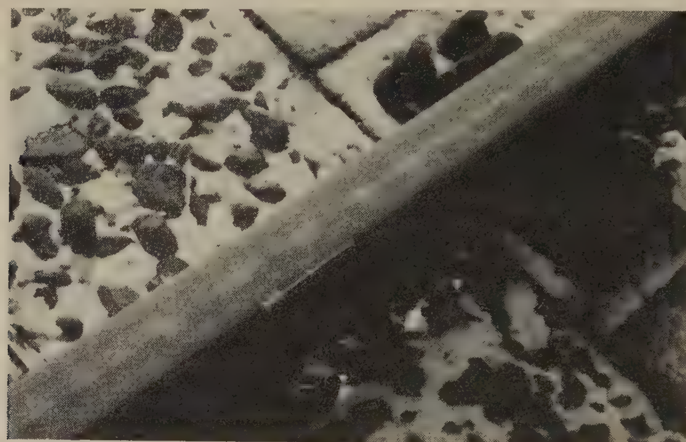


Fig. 8.

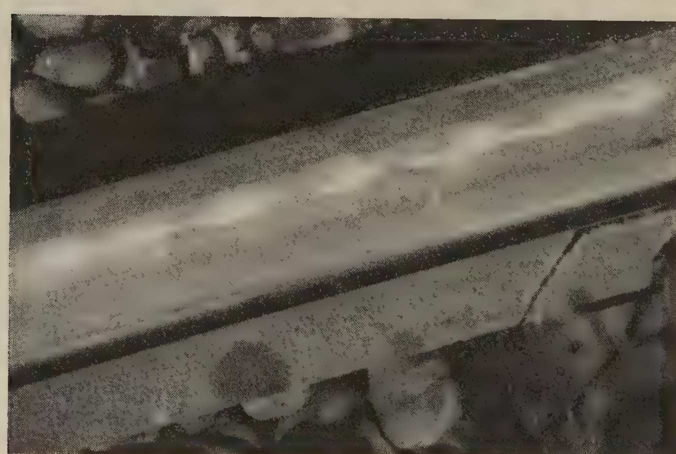


Fig. 9.

tion in the earth caused by the passage of traffic was communicated to the rail, which vibrated sympathetically. At the nodes the rail was not affected, and ordinary wear appeared at these points; the bright spots were midway between the nodes and were due to the high momentary intensity of pressure caused by the movement of minute range but very high frequency.

» Perhaps this vague guess might lead some more mathematically minded member to formulate any exact theory. »

III

Is there an ultrasonic vibration in the rail?

In the case of a regular vibration in the running surface, one might imagine that the load varied as a result (fig. 7). In this case, according to our explanation, there would be less wear in the section $D_1\ B_1\ TA_1\ C_1$ than in the adjoining section $D_2\ B_2\ TA_2\ C_2$. See also the section in figure 5. This would require a practically regular vibration, and we found here also that the result was as we deduced it theoretically. Figures 8 and 9 illustrate this.

Moreover, these waves must always form at the same place, that is to say they must be stationary waves.

For there to be stationary waves, 45 mm long, there must be two moving waves of twice the length, moving in opposite directions (fig. 10).

The speed of propagation of the transverse waves being, 3 230 m/sec (8), this would indicate a frequency of

$$\frac{3\,230\,000}{2 \times 45} = 36 \text{ kc/s !}$$

which appears to us too high for a rail of modern profile.

Further, in an article which appeared in *Schweizerische Bauzeitung* (9) Dipl. Ing. U. SCHLUMPF stated that he had attempted to measure the tractive and compressive stresses in the different parts of a rail, half way between two sleepers. He had also placed an extensometer under the rail head, which, according to all expectations, should have been subjected to compression.

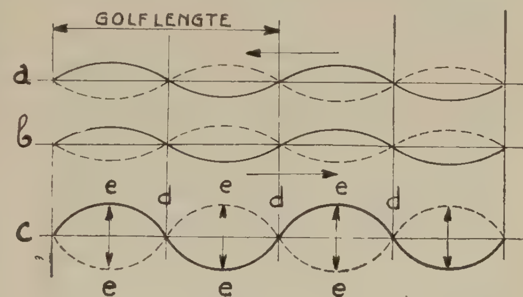


Fig. 10.
N. B. — Golflengte = length of wave.

But during the passage of a wheel, compression changed for a moment to traction and then changed again to compression. Mr. SCHLUMPF gave the following explanation. The rail head behaved for a moment as if it was not fixed to the web: the web was compressed for a moment. Personally, we draw the conclusion that, if the rail-head could have its own movement, supposing for the moment that this section were independent of the web and of the rest of the rail, as was apparently the case, it could certainly have a small amplitude high frequency vibration. But, in any case, an individual vibration with an ultra-sonic frequency of 36 kc/s, seems to us quite incredible.

On the advice of Dr. Ing. A. D. DE PATER, of the Netherlands Railways, who did not find the point as difficult to believe as we did, we consulted an article by Mr. H. J. NAAKE, which appeared in *Acustica* and was entitled « Schwingungsuntersuchungen an Eisenbahnschienen » (10). It seems to us to be of value to give below a translation of paragraph 3*d* of this article.

3d. *Vibrations of different parts of a cross section.*

It is well known from research carried out on cylindrical and rectangular bars that, with transverse vibrations above their highest natural frequency, internal movements no longer continue in the same phase. Within these bars, forces due to mass and to other elasticity thrusts are continually dispersed over the whole of the section. As a result of the special form of the rail, transverse vibrations resulting both from mass and elasticity can co-exist here. This is how it is that these resonances occur with proportionately low frequencies. The rail head and the flange act as masses, the web acts as the bending spring component and, when the rail-head and the flange move in opposite directions to one another, the web is subjected, alternately, to tractive and compressive forces.

And in paragraph 4*c : Vibrations above 4 kc/s :* Because we find, surprisingly, that deadening decreases sharply as frequency increases, we looked for high frequency vibrations also up to 80 kc/s in the rail.

In this case, the spacing of sleepers is not the determinant but rather the full length of the rail. We found that the amplitude of the vibrations only decreased along the rail from 3 to 4 db. Because less than one per cent of the energy crosses the joint, the exact position of the resonance is determined by the length of the rail. The reason for the slightness of the deadening is probably to be found in the fact that, with such frequencies, the whole of the rail section does not vibrate equally. The amplitude of the flange, becomes less than that of the rail head. Because most of the deadening is caused by the sleeper fastenings, this inequality of the amplitude in the head leads to a reduction in deadening in the head.

The spread of vibrations was not influenced by a loaded freight wagon.

Starting at about 12 kc/s the wavelengths of the two directions of vibration at a certain frequency are the same; the wave length falls by $\frac{1}{f}$, that is to say, the rate of propagation remains constant.

Starting at 35 kc/s, a new kind of sectional vibration is generated within the rail section. It may be concluded that, starting with this frequency, the rail head no longer vibrates in one single phase.

The wave length of this type of vibration is again longer than that of the vibrations when the rail head vibrates as a whole and not in parts. Above a frequency of 35 kc/s, there are virtually no points of resonance at which the rail head vibrates entirely in phase.

The shortest possible vibration wave length in which the rail head does not vibrate sectionally is 8 cm. This length

is equal to about two wavelengths of corrugation. (Note 3.) The corrugation waves have a slightly variable spacing, averaging about 4.5 cm. They may reach a height of 0.3 mm. When a train passes over a corrugated section of track the wheels « pluck » these irregularities. This produces a loud noise, the principal frequency of which is determined by the spacing of the corrugation waves and the speed of the train.

For example, when the train speed is 70 km/h the main frequency is 435 c/s. The phenomenon that we have already noticed that *twice the average length of the waves of corrugation equals the shortest wave length of the vibration, with which the rail head vibrates as a whole may, in certain circumstances, give an indication of the reason for this wear.*

IV

Corrugation is caused by high frequency vibrations.

Mr. NAAKE's theory and our own method of calculation are surprisely consistent. We, for our part, conceived the formation of corrugation as follows :

A wheel passing over a rail which is destined to suffer corrugation, causes the rail head to vibrate simply by reason of its passage. The joint may increase it (that is to say, the vibration) but the rail head vibrates in any case.

Let us take Mr. NAAKE's rail as an example. In the rail head, vibrating at 35 kc/s, antinodes and nodes form, through intersection, every 4.5 cm. The antinodes vibrate 70 000 times a second, the nodes do not vibrate. Passing over the running surface, the wheel crosses a surface the physical properties of which, in relation to resistance and to wear, vary about every 4.5 cm. First, above the nodes, the position is normal and the bright strip A-B is of normal width. But above the antinodes the wheel only bears a load for half the time; in the rising phase, that is to say in each $\frac{1}{140\,000}$ sec period. During the following phase, contact between rail and wheel is probably maintained, because of the elasticity of the wheel's tyre, but this is not *a load* on the rail. During the following rising phase an area of pressure has to be re-established. Because of the very short period $\frac{1}{140\,000}$ sec — and the high energy of the vibration, this takes the form of severe hammering. Thus the surface at the area of pressure, at the centre of the stationary wave, must be at least twice, its width must thus be at least 1.4 times the normal.

Between these two points above the nodes and above the antinodes, there is a transitional situation.

As we explained in paragraph II, the result is that wear of the running surface is greater above the nodes than above the antinodes. On the rail, which is hammering the wheel as Mr. SPADERNA believed (4), *though 130 times more frequently,* a layer of martensite is formed, as Messrs. MONNET and PALMÉ said (11).

A wheel travelling at a speed of 120 km/h (33 1/3 m a sec) is struck every 0.5 mm of its journey. As a result of this vibration, the coefficient

of friction and as a result, the wear, are reduced; moreover, the latter is also reduced by the layer of martensite.

These three causes tend to create a difference in wear along the running surface and, once begun, the hammering has no tendency to level off, as one might imagine at first sight, but rather to be accentuated until a certain limit is reached.

In Messrs. MONNET and PALMÉ'S article one fact remained unexplained : why do the wheels show such a preference for certain particular points on the rail ?

It seems of interest to quote the following few lines of the summary of their article : « It is, in fact, a process of selection, from amongst the periodic movements which can cause the phenomenon those, the frequency of which, on the one hand, is such that, at the speeds encountered, the corresponding wave lengths are found in the rail and the force of which, on the other hand, might provoke temperatures equal to or higher than those at the points of transformation (under the given conditions, of course) to be reached. »

It seems to us that we have demonstrated the reason why all the wheels that pass seem to choose certain particular points, namely the antinodes of the stationary waves.

One might even ask why all rails do not develop corrugation, given that, according to Mr. NAAKE's thesis, all rails are basically pre-disposed towards this trouble. We have asked ourselves this very question. In the course of our research we examined a section of new track which suggested to us the solution. The rails of this track came from two rolling mills which we will call A and B. They had the same profile and were of the same age; they were delivered to the same specifications and put into service on the same date. All the 30 m long rails consisted of two parts welded end to end in the workshop, normally mark A to mark A and mark B to mark B. And since deliveries from A and B had been made irregularly, one found successively in the track a number of A rails and then a batch of B rails. Both makes showed corrugation, that from A being perhaps a little more severe than that from B. But both showed very distinctive corrugated wear : the A's almost invariably with a 37 mm wave length, the B's with 62 mm. During our investigations, we found a 30 m rail consisting of 15 m mark A and 15 m mark B, flash-butt welded end to end like the others.

In this rail, the two parts showed each their own particular characteristics ! Part A showed corrugation with a wave length of 37 mm and part B with 62 mm. From this observation we drew the conclusion that the measurement made by Mr. NAAKE did not apply to all rails of the same profile. If he had carried out measurement on one of the B rails he would have concluded that the « shortest possible wave length of the vibration with which the rail head does not vibrate sectionally is *125 mm ! This is the vibration which determines the length of the waves.* There evidently exists in rails, or rather in rail heads, a particular characteristic which influences the frequency of the vibration. But what ?

V

Tractive tension inside the rail head determines the frequency of vibration.

We would recall in this connection the laws of Mersenne published in 1636 in his work *L'Harmonie Universelle*. The second law, concerning vibration, is formulated roughly as follows: When a chord and its length remain unchanged, but the tension is changed, the frequency changes proportionally to the square root of the tractive tension.

This was a guide by which to direct our researches. As far as we know none of those who have investigated the question of corrugation have had their suspicions roused with regard to internal tensions. Presumably, they supposed that the algebraic sum of these internal tensions was zero; that they cancelled each other out and as a result had no influence on the vibrations. By research, we have obtained a graphical picture showing the distribution of internal stresses in a section of rail. There is reason to believe that a rail of the same profile as that considered by Mr. NAAKE was under examination (S 49 German 49 kg/m profile). There is an article by Dr. Ing. H. MEIER (12) from which we have taken figure 11. It shows that the rail head and a large part of the flange undergo only tractive tensions and that, as a result, it is the web which is compressed. These tensions originated largely during the straightening carried out by the roller straightening machine.

In our view it is the remarkable distribution of internal tensions in the rail section which causes the distinct kinds of vibrations discovered by Mr. NAAKE.

This reasoning also leads to the idea that, in a certain sense the rail head may be compared with a tight chord.

If the law of Mersenne, quoted above, also applied to this case, the tensions in the rail heads A and B would be in the proportion of $62^2 : 37^2$ or $\sim 3 : 1$.

If our deductions were confirmed, it would be possible, by applying NAAKE's method, to determine in advance the length of waves of future corrugation in new rails and to obtain empirically information on the internal stresses of different profiles.

T.T. rails [1] must be excluded from this argument. These rails have a special feature which we have photographed during grinding. Figure 12 shows the results. The grinding, carried out with a small petrol motor (fig. 13 — grinding long wave corrugation) can be used normally between the passage of trains.

The aim of the grinding shown in figure 12, is to retain the outline of this extreme irregularity and, if possible, to draw conclusions from it.

Figure 14 shows the section of a T.T. rail, according to Prof. Dr. MEIER's article (12). It shows that, in such a section, there must be a variety of tensions with the necessary result that the various beds vibrate in their own way individually.

We have allowed for the fact that long welded rails are not affected by corrugation except at the two ends, which may spread: this is less the result of the absence of joints than of the changes in tension in the rail head, due to the changes in temperature.

(1) T.T. = traité thermiquement, thermally treated.

The frequency and length of wave are modified as a result. But an article by Mr. LAMOTTE (13) shows us that corrugation is also possible with these long rails.

In this article he says that rails laid in the United States are less liable to corrugation than European rails (the proportion is 1 to 6) without this difference having been explained satisfactorily so far.

In our view, the fact that it is the controlled cooling which reduces tensions could be the solution.

VI

The remedy.

In order to combat the development of corrugation, we considered that internal tensions must be reduced. Our first idea led in the direction of controlled cooling and also cooling in the course of which the flange and the web would be covered with infusorian earth, given that, according to MEIER (12), new profiles are not thermically balanced.

Slowing down the cooling of these

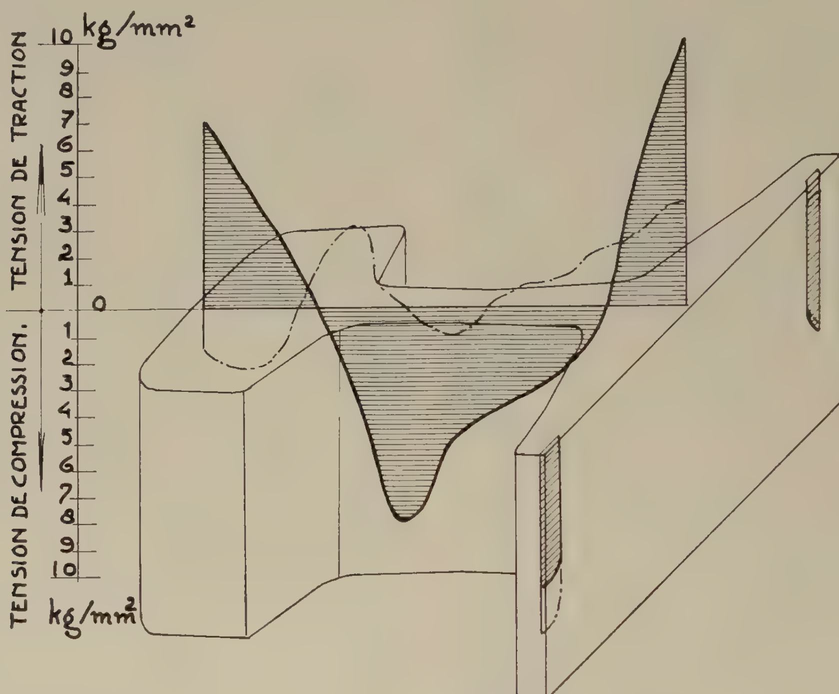
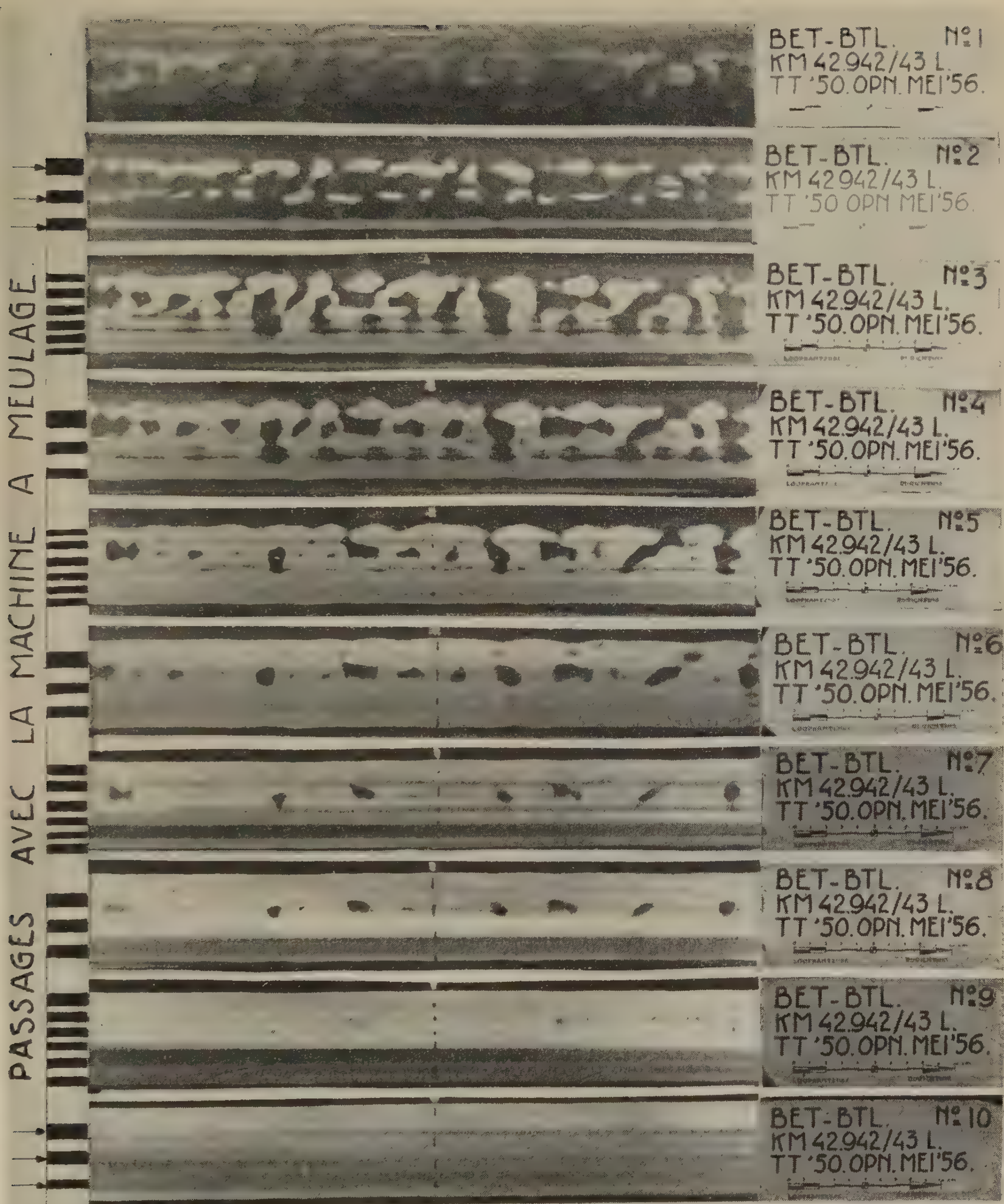


Fig. 11. — Internal tensions in a rail.

—.—.—.— After cooling.
———— After straightening.

N. B. — Tension de compression = compressive tension. — Tension de traction = tractive tension.

Extérieur de la voie.



The arrow is 10 cm long.
It is on the wheel flange side and shows the direction of running.

Fig. 12.

Explanation of French terms :

Extérieur de la voie = outside of the track. — Passages avec la machine à meulage = passages with the grinding machine.

parts, while leaving the rail head to cool normally naturally produces an improvement in the internal stresses But since these stresses are thought to be caused mainly by the roller straightening machine we were led to recommend a method which, in our view,

Fig. 13.

would be as serviceable in combating corrugation on new rails as on rails in service.

The principle is based on the modern method of straightening by oxyacetylene flame (la chaude de retrait), namely hot straightening.

Heat is directed on a certain point on the metal, the expansion of which is prevented by the surrounding metal, which remains relatively cold.

At a given moment, when the limit of elasticity, which is lowered as a result of the additional heat, is reached the metal at the heated place will flow. the metal will be upset a little.

As it cools, a tractive tension is created at the point where originally the metal had no internal stress.

According to figure 11, there is already a substantial compressive tension in the web of the rail, the maximum being about 2 cm below the rail head.

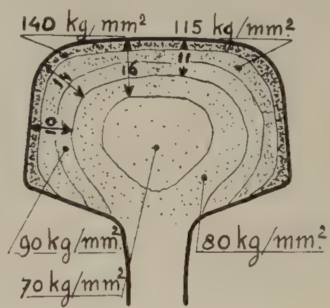


Fig. 14.

By heating the web of the rail from each side, 2 or 3 cm below the rail head, that is to say where the compressive tension is greatest (see fig. 11) using a set consisting of at least two oxyacetylene torches, we consider that a temperature of 300 to 400° C. is sufficient to reach the limit of elasticity, so that the web at this point will flatten and the tractive tension in the rail head and the flange, lacking support in the web, cannot then be maintained.

In order not to impede this movement, there may be occasion to loosen slightly the fastenings of the rail to the sleepers and the fish plate bolts when the rails are installed on the track.

On the other hand, when the fastenings remain fixed, the compressive tension is increased by the expansion caused by the conductivity of the metal, which may produce flattening at a lower temperature, which would, in any case, be preferable.

When the tractive tension has been reduced the rail head will have a frequency which is proportionately reduced.

We assume that, in this case, when corrugation is not very serious, normal rail traffic will be sufficient to erase it.

Where corrugation is pronounced, grinding may be applied by the use of petrol driven machine, for example, like that shown in figure 13, in order to grind the layer of martensite on the bright band, solely at the centre of the running surface. In this way, this band can be flattened and the side bands will be flattened quickly by the traffic since they will be exposed to « fretting » corrosion.

So far as new rails are concerned, we consider it should be possible to prevent the appearance of corrugation in the same way as we have recommended for rails already laid.

The internal tensions originated mainly during passage through a roller straightening machine.

It appears to us that the part of the web of the rail referred to could be heated during this straightening.

In this case, this strip of the rail web, which is heated much more than the surrounding metal, will be less capable of absorbing compressive forces; and then by contracting more than the rail head and the flange it will reduce the tractive tension which appears eventually in these two parts.

But all of these conclusions are only theoretical, since we have not yet had time or the opportunity to apply them, first in the laboratory and then in practice. For this reason we should be glad to receive any information on methods used and results obtained.

Addendum.

After completing the above article, we have had the opportunity to heat several lengths of new rail of type A in the laboratory in the manner that we proposed.

The rail of NP 46 profile, weighing 46.9 kg a metre, was not fixed. The thickness of the web was 14 mm and the length was 3.50 m, of which 3.25 m were warmed by two No. 8 blow pipes, one at each side of the web.

The speed of movement of the blow pipes was about 50 cm a minute and a temperature between 400° and 450° C. was produced locally in the web. The rail head reached a temperature of 120° C after the passage of the burners.

Thus, in track in service, it might be desirable, according to the type of construction and the prevailing temperature, somewhat to speed up the cooling.

After normal cooling the length of rail had fallen by 0.455 mm per metre. This might indicate that the tractive tension in the rail head and in the flange had been reduced by 950 kg per sq. cm.

It appears to us that the rail is much improved on this way, as a result of the reduction in internal stresses, but, in order to avoid the risk of a surface

hardening of the web (although near the neutral axis), it may be desirable not to heat the web in the neighbourhood of the rail head.

We hope that we shall have the opportunity to attempt the heating we recommend in some sections of rail which have been affected by serious corrugation and which are in use on a heavily trafficked line. In this case, it should be possible to establish quickly the actual difference between the characteristics of the running surface of processed and non-processed sections.

Bibliography.

(1) John DEARDEN : « The Wear of Steel Rails : « a Review of the Factors involved. » *Proc. Inst. Civ. Eng.*, Oct. 1954, Rly. Paper No. 53.

(2) Prof. Dr. M. FINK : *Organ*, 15-X-1929 (20), p. 405 : « Neue Ergebnisse auf dem Gebiet der Verschleissforschung ».

(3) Dr. W. SPÄTH : *Glas. Ann.* 1953 (4), p. 88 : « Physikalisch-chemische Grunderscheinungen des Verschleisses ».

(4) K. C. SPADERNA : *Glas. Ann.* 1954 (2), p. 42 : « Das Rätsel der Riffeln auf Eisenbahnschienen ».

(5) K. C. SPADERNA : *Bull. of the Int. Railway Congress Association*, July 1956, p. 649 : « The enigma of rail corrugation on railways ».

(6) A. MEYER : « Zur Klärung bedeutsamer Fragen im Strassenbahnoberbau und insbesondere der Riffelbildung auf den Schienen. » Berlin 1915.

(7) *Proceedings of the Institution of Civil Engineers*, 1914. Vol. 197, p. 170.

(8) Dr. L. BERGMANN : « Der Ultraschall und seine Anwendung in Wissenschaft und Technik », 5. Druck 1949.

(9) Dipl. Ing. U. SCHLUMPF : *Schweiz. Bauztg.*, 2-I-1954, p. 6 : « Über eine bisher nicht berücksichtigte Beanspruchungsart von Eisenbahnschienen ».

(10) H. J. NAAKE : *Acustica*, 3 (1953), p. 139 : « Schwingungsuntersuchungen an Eisenbahnschienen. »

(11) MONNET & PALMÉ : *Revue Générale des Chemins de fer*, 74 (1955), p. 214 : « L'usure ondulatoire des rails. Phénomène à seuil. »

(12) Dr. Ing. H. MEIER : *E. T. R.*, 1953 (6/7 and 8/9), pp. 379 et 453 : « Die Verbesserung der Eisenbahnschiene. »

(13) H. LAMOTTE : *Transmondia*, 25 (1957), 10, p. 25 : « Le rail, sa vie, ses maladies. »

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OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

International Railway Congress Association.

Meeting of the Permanent Commission, held on the 7th December 1957.

The Permanent Commission of the International Railway Congress Association held a meeting on the 7th December 1957, at 3 p.m., in the Belgian National Railways Headquarters Offices, at Brussels.

* * *

Mr. DE VOS, *President,* opening the meeting, addressed a warm welcome to the personalities present and referring to the sad news of the railway accident which just happened in England, expressed his deepest sympathy to the British delegation. Then, he requested the Assembly to approve the Minutes of the last meeting held in Brussels, on the 1st December 1956.

* * *

Mr. GHILAIN, *General Secretary,* informed the Meeting of the modifications to be effected in the constitution of the Permanent Commission since the last session.

The Assembly ratified the nomination as Members of the Permanent Commission of the following personalities :

Prof. Dr. jur. Heinz Maria OEFTERING, First President of the Vorstand of the Deutsche Bundesbahn, will replace Prof. Dr.-Eng. E. FROHNE, retired;

Dr. Eng. Moustapha KHALIL, Minister of Communications, Egypt, will replace Colonel Gamal SALEM, now in another position;

Mr. Abdel Moneim AZMY, Under-Secretary of State, Ministry of Communications, Egypt, will replace Mr. Abdel Moneim RASHAD, former Deputy General Manager of the Railways;

Mr. Agustin PLANA, Under-Secretary of State for Public Works and present President of the Administrative Board of the RENFE, will replace Mr. A. PEÑA BOEUF;

Mr. P. C. MUKERJEE, Chairman, Railway Board, Ministry of Railways, Government of India, will replace Mr. A. PANDE, retired;

Mr. Hiroshi SAITO, Director of the Foreign Affairs Department of the Ja-

panese National Railways will succeed to Mr. Satoshi ISOZAKI;

Dr. Eng. W. WYRZYKOWSKI, Vice-Director of the Railway Research and Tests Scientific Institute of the Polish State Railways will replace Mr. L. GEHORSAM who has resigned from his position;

Dr. H. BORN, General Secretary of the « Union d'Entreprises Suisses de Transport », will replace Mr. X. REMY, retired;

Furthermore, in accordance with art. 6 of our Rules and Regulations, and the prescribed procedure having been observed, it was decided to maintain as Member, up to the next Congress, Dr. Eng. A. ATTISANI, Chief of the Rolling Stock and Traction Department of the Italian State Railways, who retired recently.

— *The complete List of the Members of the Permanent Commission is given in the Appendix.*

* * *

Following a request made by the Railway Board of the Indian Government Railways, Mr. GHILAIN proposed the allocation of an additional mandate to India owing to the considerable mileage of this railway system.

— This proposal was adopted by the Assembly.

* * *

The GENERAL SECRETARY then gave particulars to the Meeting about the preparatory works relative to the Madrid Congress and stated that all necessary arrangements have been made to publish in time the reports and special reports.

The PRESIDENT called upon Mr. GARCIA LOMAS, *Vice-President of the Administrative Board of the RENFE and President of the Executive Organising Committee,* who reported on the measures already taken by the Spanish Authorities in view of the organisation of the Madrid Congress.

Mr. GARCIA LOMAS stated to the Assembly that the Inaugural Session will be held on the 29th September 1958 and the Closing Meeting on the 7th October. Then, giving full particulars about the programme of the Session, he named the Spanish personalities who will constitute the General Bureau of the Session and Local Organising Commission. He added that he hoped that His Exc. Generalissimo FRANCO, Head of the State, will agree to be President of Honour of the Session, His Exc. the Minister of Public Works being Vice-President of Honour.

He gave also certain information regarding the travelling facilities granted to the delegates and their families in Spain, hotel accommodations, the organisation of the Congress itself and the functioning of the various services. The Congress will be held at the « Trade Union's House », equipped with the modern installations needed for large international meetings.

Mr. GARCIA LOMAS ended by saying that all efforts will tend to make the Madrid Congress as great a success as all the previous Sessions.

The PRESIDENT and Mr. LALONI, in the name of the Assembly, thanked

Mr. GARCIA LOMAS for his interesting report.

— The Assembly approved all the arrangements already made.

* * *

The provisional accounts (receipts and expenditures) for the financial year 1957 were approved as well as the proposed budget for the financial year 1958.

Mr. GHILAIN, General Secretary, then reported on the favourable financial position of the Association and stated that it was suggested, as for the financial year 1957, to call in 1958 for only 50 % of the amount of the contribution fixed previously at 0,28 Gold-franc per kilometre.

— This proposal was approved.

* * *

Mr. GHILAIN stated to the Meeting that during 1957 only one resignation: that of the *East of Seeland Railway Company*, Denmark, (47 km), was recorded; but, on the other hand we have registered the affiliation of the *Nyassaland Railways* (508 km).

The International Railway Congress Association includes therefore at present the same number of members as at the last session, i.e. 34 Governments, 10 Organisations and 101 Railway Administrations with a total mileage of 601 842 km (approx. 374 000 miles).

* * *

The PRESIDENT stated that it was advisable to fix at present the date of the next Meeting of the Permanent Commission owing to the difficulties which probably will be encountered to find hotel accommodations in Brussels during the period of the International Exhibition and he suggested to held that Meeting at Ostend on the 2nd June 1958. *(Unanimously approved.)*

* * *

The Meeting ended after the examination of various items concerning the activities of the Association in particular in connection with the « Bulletin Sales » and « Advertising » departments.

P. GHILAIN, *General Secretary.* M. DE VOS, *President.*

List of Members of the Permanent Commission

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(7th DECEMBER 1957)

President :

M. **De Vos** (2), Directeur Général de la Société Nationale des Chemins de fer belges; 19, rue du Beau-Site, Bruxelles.

Vice-presidents :

J. **Goursat** (3), Directeur de la Région du Nord de la Société Nationale des Chemins de fer français; 18, rue de Dunkerque, Paris (X^{e});

M. **Crem** (3), Directeur du Service de l'Exploitation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

Members of the Executive Committee :

E. **Dorges** (2), Secrétaire Général Honoraire aux Travaux Publics et aux Transports, Délégué Général du Ministre pour les Affaires Internationales au Ministère des Travaux Publics et des Transports; 244, boulevard Saint-Germain, Paris;

Sir John **Benstead** (3), Deputy Chairman of the British Transport Commission; 222, Marylebone Road, London, N.W.1;

Sir Gilmour **Jenkins** (1), Permanent Secretary, Ministry of Transport and Civil Aviation (Great Britain); Berkeley Square House, Berkeley Square, London, W. 1.

Ex-presidents of session, members ex-officio :

D^{r} Ing. G. **di Raimondo**, Directeur Général des Chemins de fer de l'Etat italien (*retired*); Rome;

Ibrahim Fahmy **Kerim**; Le Caire;

D^{r} W. **Meile**, ancien Président de la Direction générale des Chemins de fer fédéraux suisses; Brügglerweg, 11, Berne;

General Sir Brian **Robertson**, Bart., G.C.B., G.B.E., K.C.M.G., K.C.V.O., D.S.O., M.C., Chairman, British Transport Commission, 222, Marylebone Road, London, N.W.1.

Members :

L. **Armand** (2), Président du Conseil d'administration de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

D^{r} Ing. A. **Attisani** (2), Chef du Service du Matériel et de la Traction des Chemins de fer italiens de l'Etat (*retired*); Florence;

Abdel Moneim **Azmy** (2), Sous-Secrétaire d'Etat au Ministère des Communications d'Egypte; Le Caire;

Sir John **Benstead** (already named);

R. **Besnard** (1), Chef de Service adjoint au Directeur général des Chemins de fer et des Transports, Ministère des Travaux publics et des Transports; 244, boulevard Saint-Germain, Paris;

David **Blee** (2), General Manager, London Midland Region; British Railways; 222, Marylebone Road, London, N.W.1;

Dr. H. **Born** (3), Secrétaire Général de l'Union d'Entreprises Suisses de Transport, Bundesgasse 28, Berne;

Ch. **Boyaux** (1), Directeur Général de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

Dipl.-Ing. A. **Brill** (2), Ministerialdirektor, Leiter der Maschinentechnischen- und Beschaffungsplanungsabteilung der Hauptverwaltung der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

A. **Brouckaert** (1), Directeur du Service du Matériel et des Achats de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles;

E. **Clarembaux** (2), Directeur du Service de la Voie de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles;

R. **Claudon** (2), Inspecteur Général des Ponts et Chaussées, Vice-Président du Conseil d'administration de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

(1) Retires at the 17th session.
(2) Retires at the 18th session.
(3) Retires at the 19th session.

Dr R. **Cottier** (3), Directeur de l'Office Central des Transports Internationaux par Chemins de fer; Berne;

T.C. **Courtney** (2), Chairman of the Coras Iompair Eireann; Kingsbridge Station, Dublin;

M. **Crem** (already named);

Csanadi (3), Directeur Général des Chemins de fer de l'Etat hongrois; Budapest;

Dr Ing. A. **Cuttica** (2), Directeur Général Adjoint et Conseiller d'Administration des Chemins de fer italiens de l'Etat; Rome;

Ph. **Dargeou** (2), Directeur Général Adjoint de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IXe);

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I. — BOOKS.

In French.

1957 621 .31

Centrales thermiques 1957. Numéro spécial (décembre 1957) de la *Technique Moderne*.

Paris, Dunod, éditeur, 92, rue Bonaparte. Un fascicule (24 × 31.5 cm) de CXII + 90 pages, avec de nombreuses illustrations. (Prix : 1 250 fr.fr.)

1957 313 : 655 (4)

COMMISSION ÉCONOMIQUE POUR L'EUROPE. DIVISION DES TRANSPORTS. (Nations Unies.)

Bulletin Annuel de Statistiques de Transports Européens 1956. *(Huitième année.)*

Genève, Office Européen des Nations Unies, Palais des Nations. 96 pages, avec graphiques et nombreux tableaux. (En français et en anglais.) (Prix : 4 fr. suisses.)

1957 624

ZAYTZEFF (S.).

Calcul des constructions hyperstatiques par les méthodes de relaxation.

Paris, Dunod, éditeur. Un volume (15 × 24 cm) de 329 pages et nombreuses figures et tableaux. (Prix : 2 300 fr.fr.)

In German.

1957 625 .1 (02

Elsners Taschenbuch für den bautechnischen Eisenbahndienst, 29. Jahrgang 1957.

Frankfurt (Main), Dr. Arthur Tetzlaff-Verlag. 480 Seiten DIN A 6, mit zahlreichen Abbildungen. (Preis : DM 5.—. Vorzugspreis für Bundesbahnbedienstete : DM 4.50.)

1957 385

Jahrbuch des Eisenbahnwesens. 8. Folge. Herausgeber Prof. Dr.-Ing. Th. VOGEL.

Darmstadt, Carl Röhrig Verlag. 210 Seiten Text, DIN A 4, mit vielen Bildern, Zeichnungen und Tafeln auf Kunstdruckpapier. (Preis : Halbleinen, DM 8.50.)

1957 621 .137

NIEDERSTRASSER (L.). Mitarbeit von **F. WITTE und H. KIRSCHSTEIN.**

Leitfaden für den Dampflokomotivdienst.

Frankfurt (Main), Verkehrswissenschaftliche Lehrmittelgesellschaft m.b.H. 9. Auflage. DIN A 5, XXIV und 606 Seiten, 360 Abbildungen, mit Beilage von 7 Tafeln, 5 Anhängen und 3 Schaltbildern. (Preis : geb., DM 24.—.)

1957 624 .2

Dr.-Ing. POPP (C.)

Zur genaueren Berechnung der Fahrbahn-Längsträger stählerner Eisenbahnbrücken. 2. Teil : **Zahlentafeln zur Berechnung der Einflusslinien.**

Köln, Stahlbau-Verlag G.m.b.H.

In English.

1958 621 .335

British Electric Trains.

One brochure (6 1/4 × 4 in.) of 65 pages, illustrated. Hampton Court, Surrey : Ian Allan Limited, Craven House. (Price : 2 s. 6 d.)

1957 385 (08 (59)

HARRISON (C.G.).

Malayan Railway Administration Report. Annual Report for the year 1956.

Published by the Malayan Railway Administration, Kuala Lumpur. (Price : $ 5 (M) — £ 0.12.6 d.)

1958 621 .438

LUCAS (J.) and POLLOCK (J.F.).

Gas Turbine Materials.

London : Temple Press, Ltd, Bowling Green Lane, E.C.1 (Price : 25 s.)

1957 526

Proceedings of the Fourth International Conference on soil mechanics and foundation engineering. Vols. I and II.

London : Butterworth's Scientific Publications, 88, Kingsway, W.C.2. (Price : £ 17.10.0 d.)

1957 62

STEED (R.W.).

Mechanical engineering.

London : R. Hale Ltd., 63, Old Brompton Road, S.W.7. (Price : 8 s. 6 d.)

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels, (See « Bibliographical Decimal Classification as applied to Railway Science », by L. WEISSENBRUCH, in the number for November 1897, of the *Bulletin of the International Railway Congress*, p. 1509).

1957 **531**
STEPHENS (R.C.) and **WARD (J.J.).**
Applied mechanics.
London : Cleaver Hume Press, Ltd., 31, Wright's lane, Kensington, W.8. (Price : 12 s. 6 d.)

1955 and **1956** **385** (062 (931
The New Zealand Railway Observer. Vol. 12, 1955; Vol. 13, 1956.
Official Journal of The New Zealand Railway & Locomotive Society.
Obtainable from : T.A. McGAVIN, Hon. Editor, 86, Totara Crescent, Lower Hutt, New Zealand.

In Italian.

1957 **621** .331 (45)
MINISTERO DEI TRASPORTI, FERROVIE DELLO STATO.
Attivazione dell'impianto di telecomando, telecontrollo e telemisura della sottostazione elettrica di Agropoli dalla sottostazione di Omignano.
Roma, Tipo-Litografia F.S., 13 pagine & fig.

[**016.** 385 (05]

II. — PERIODICALS.

In French.

Acier - Stahl - Steel. (Bruxelles.)

1958 **656** .211 .5 (44)
Acier - Stahl - Steel, janvier, p.6.
PASCAUD (S.). — L'évolution des **abris de quai** à la S.N.C.F. Couverture des plates-formes d'accès. (3 000 mots & fig.)

1957 **624** .2
Acier - Stahl - Steel, janvier, p. 34.
DECARPENTRIE (E.). — Influence des congés de raccordement dans le calcul des **poutres Vierendeel.** (2 000 mots & fig.)

Bulletin de l'Association Suisse des Electriciens. (Zurich.)

1957 **621** .31
Bulletin de l'Assoc. Suisse des Electriciens, 21 décembre, p. 1153.
RINGGER (W.). — **Messgruppen in Hochspannungsnetzen.** (3 500 mots & fig.)

1957 **62** (01
Bulletin de l'Assoc. Suisse des Electriciens, 21 décembre, p. 1161.
ORTLIEB (I.). — Anwendung der **Stichprobenprüfung.** (2 000 mots & fig.)

Bulletin des C.F.F. (Berne.)

1958 **656** .2
Bulletin des C.F.F., janvier, p. 3.
HARTMANN (G.). — Quelques **réalisations de l'automation dans le domaine ferroviaire.** (1 600 mots.)

1958 **656** .223 .2
Bulletin des C.F.F., janvier, p. 6.
LAMBERT (A.). — Le **nouveau règlement pour l'emploi réciproque des wagons en trafic international** (R I V). (1 000 mots.)

Bulletin des Transports Internationaux par Chemins de fer. (Berne.)

1957 **385** .113 (492)
Bull. des transp. intern. par ch. de fer, novembre, p. 307.
La **Société des Chemins de fer Néerlandais** en 1956. (1 000 mots & tableaux.)

Economie et Technique des Transports. (Zurich.)

1957 **656** .211 (494)
Economie et Technique des Transports, n° 121 (10-12), p. 150.
PORTMANN (M.). — Die **Erweiterung des Personenbahnhofs** in Bern. (1 500 mots & fig.)

1957 **621** .335 : **625** .62 (492)
Economie et Technique des Transports, n° 121 (10-12), p. 163.
KOLDIJK (S.S.). — **Automotrices ultra-légères** des Tramways de Rotterdam. *(Suite et fin.)* (1 500 mots & fig.)

1957 **625** .2 (494)
Economie et Technique des Transports, n° 121 (10-12), p. 167.
BÄCHTIGER (A.). — Chemin de fer Rhétique. Dix ans de nouveaux efforts et de **modernisation et développement, de 1948 à 1957, du matériel roulant et du service de traction.** *(Suite et fin.)* (1 500 mots & fig.)

1957 **621** .335 : **625** .62 (43)
Economie et Technique des Transports, n° 121 (10-12), p. 174.
REBBELMUND (G.). — Die **Gelenkwagen** der Rheinischen Bahngesellschaft A.G. *(Suite et fin.)* (1 000 mots & fig.)

L'Industrie des Voies ferrées et des Transports automobiles. (Paris.)

1957 **625** .62 (43)
L'Industrie des Voies ferrées et des Transports automobiles, décembre, p. 177.
SCHINGS (P.). — **Nouvelles voitures à grande capacité** des Tramways d'Aix-la-Chapelle. (1 000 mots & fig.)

Organisation Scientifique. (Bruxelles.)

1957 **385** .587
Organisation Scientifique, décembre, p. 299.
WANTY (J.). — Réflexions sur la **recherche opérationnelle.** (2 500 mots.)

Revue Générale des Chemins de fer. (Paris.)

1957 **625** .28 (44)
Revue Générale des Chemins de fer, décembre, p. 653.
MERMIER & BAILLEUX. — Une **doctrine d'utilisation des locomotives Diesel de moyenne puissance** sur la Région du Sud-Est de la S.N.C.F. (4 000 mots & fig.)

1957 **621** .336 (44)
Revue Générale des Chemins de fer, décembre, p. 665.
GARREAU & DUPONT. — Le **pantographe des locomotives électriques.** (Etudes et Essais de la S.N.C.F.). (7 000 mots & fig.)

1957 **385** .1
Revue Générale des Chemins de fer, décembre, p. 687.
FEYEUX. — Le problème de la **situation financière des Chemins de fer.** (6 000 mots.)

1957 **625** .13 (44)
Revue Générale des Chemins de fer, décembre, p. 697.
LECOUILLARD. — **Reconstruction partielle et remise générale en état du tunnel « Sainte-Catherine »** (ligne Paris-Le Havre). (3 500 mots & fig.)

Revue Générale de Mécanique. (Paris.)

1957 **62** (01 & **621** .392
Revue Générale de Mécanique, novembre, p. 475.
ROBLIN (P.). — L'**influence des soudures dans le comportement des ouvrages métalliques.** *(A suivre.)* (2 000 mots & fig.)

1957 **62** (01
Revue Générale de Mécanique, novembre, p. 491.
HEMARDINQUER (P.). — Le **contrôle ultra-sonore des matériaux.** Technique et développement. *(A suivre.)* (2 000 mots & fig.)

1957 **621** .9
Revue Générale de Mécanique, décembre, p. 521.
WEILL, PELISSIER et HESSE. — **Nouveautés Techniques présentées à la 5e Exposition européenne de la machine-outil** à Hanovre (15-24 septembre 1957). (22 000 mots & fig.)

1957 **621** .9
Revue Générale de Mécanique, décembre, p. 548.
Abbé CAYÈRE. — **Recherches expérimentales sur le Contrôle opératoire. Contrôle opératoire pendant les opérations d'alésage et de tournage.** *(A suivre.)* (1 500 mots & fig.)

Revue de la Société Royale Belge des Ingénieurs et des Industriels (Bruxelles).

1957 **691**
Revue de la Société Royale des Ingénieurs et des Industriels, décembre, p. 464.
VERMEIREN (T.). — **Le traitement magnétique des liquides contre la corrosion et l'incrustation.** (5 000 mots & fig.)

Technique et Humanisme. (Liège.)

1957-1958 **621** .116
Technique et Humanisme, n° 2, p. 31.
BUCHET (E.). — **Le calcul thermique des générateurs de vapeur.** *(Suite.)* (10 000 mots & fig.)

Les Transports Publics. (Berne.)

1958 **625** .6 (494)
Les Transports Publics, janvier, n° 1, p. 3.
Dr. H. BORN. — **Les chemins de fer privés et l'année 1957.** (1 500 mots.)

1958 **624** (494)
Les Transports Publics, janvier, n° 1, p. 5.
La Construction d'un nouveau pont sur la ligne de chemin de fer Vitznau-Rigi. (1 200 mots & fig.)

La Vie du Rail. Paris.)

1957 **625** 1. (44)
La Vie du Rail, 3 novembre, p. 3.
A Paris-Nord avec le **train bétonneur.** (500 mots & fig.)

1957 **656** .222 .5 (56)
La Vie du Rail, 1er décembre, p. 3.
DURUKAL (H.). — **L'Orient-Express Anatolien.** (1 000 mots, carte & fig.)

1957 **621** .33 (44)
La Vie du Rail, 8 décembre, p. 3.
L'électrification du réseau français. (1 500 mots & fig.)

1957 **621** .335 (492 + 493)
La Vie du Rail, 8 décembre, p. 14.
De **nouvelles rames électriques bitension** à éléments multiples entre Amsterdam et Bruxelles. (800 mots & fig.)

1957 **625** .172 (44)
La Vie du Rail, 8 décembre, p. 16.
LETURGIE (G.). — **Révision du nivellement des voies ferrées par la méthode dite de « soufflage court ».** (1 000 mots & fig.)

1957 **385** (09 (44)
La Vie du Rail, n° 625, numéro spécial (Noël), p. 3.
Regards sur le Rail français. Interview de M. Ch. BOYAUX, Directeur Général de la S.N.C.F. (5 000 mots & fig.)

1957 **385** (09 (52)
La Vie du Rail, n° 625, numéro spécial (Noël), p. 28.
BEGUE (A.). — Les **Chemins de fer Japonais.** (3 000 mots & fig.)

In German.

Archiv für Eisenbahnwesen. (Berlin.)

1957 **385** (09 .3 (42)
Archiv für Eisenbahnwesen, Heft, 4, S. 429.
WEHDE-TEXTOR. — **Die Britischen Eisenbahnen im zweiten Weltkrieg, 1939 bis 1945.** (24 000 Wörter.)

1957 **656**
Archiv für Eisenbahnwesen, Heft 4, S. 460.
OTTMANN (K.). — **Öffentlicher Dienst und Produktivität.** (20 000 Wörter.)

1957 **347** .763 .4
Archiv für Eisenbahnwesen, Heft 4, S. 503.
PISCHEL (W.). — **Rückwirkung unterschiedlicher Wirtschaftsordnungen auf das nationale und zwischenstaatliche Eisenbahnfrachtrecht.** (11 000 Wörter.)

Die Bundesbahn. (Darmstadt und Köln.)

1957 **385** (09 (43)
Die Bundesbahn, Nr. 19, Oktober, S. 1453.
BURGER (R.). — Die **Bundesbahndirektion Regensburg.** (5 000 Wörter, Karten & Abb.)

1957 **656** .2 (43)
Die Bundesbahn, Nr. 19, Oktober, S. 1483.
SCHERSCHMIDT (G.). — Die **Transportfunktion der Eisenbahn** für die ostbayerische Wirtschaft. (7 000 Wörter & Abb.)

1957 **725** .3 (43)
Die Bundesbahn, Nr. 19, Oktober, S. 1510.
BÖRNER (H.). — Der **Wiederaufbau** im Bezirk Regensburg. (2 000 Wörter & Abb.)

1957 **656** .211 .7 (43)
Die Bundesbahn, Nr. 20, Oktober, S. 1534 und 1539.
FLEMMING (F.). — Das **neue Eisenbahn-Hochseefährschiff « Theodor Heuss »** der Deutschen Bundesbahn. (2 500 Wörter & Abb.)
OELERT (W.). — Das **Eisenbahnfährschiff « Theodor Heuss »** und seine schiffbaulichen und maschinellen Einrichtungen. (7 000 Wörter & Abb.)

1957 **656** .23 (43)
Die Bundesbahn, Nr. 21, November, S. 1603.
GOSSE (H.). — **Beförderungspreise und Preisniveau.** (1 600 Wörter.)

1957 **625** .244 (43) & **656** .225 (43)
Die Bundesbahn, Nr. 21, November, S. 1612.
REINBRECHT (H.). — **Fischwirtschaft und Bundesbahn.** (7 000 Wörter & Abb.)

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Die Bundesbahn, Nr. 21, November, S. 1629.
WALZ (W.). — Wo steht die **Palettierung?** (4 000 Wörter & Abb.)

1957 **625** .28 (43)
Die Bundesbahn, Nr. 21, November, S. 1636.
KLINGENSTEINER (J.) & EBNER (E.). — **Der Zugförderungsdienst** im Fahrplanjahr 1957/58. (4 000 Wörter & Tabellen.)

1957 **656** .211 .5 (73)
Die Bundesbahn, Nr. 21, November, S. 1647.
Ein neuer Superlativ aus den U.S.A. : die **neue Fahrkartenausgabe** der Pennsylvania Station, New York, N.Y. (1 500 Wörter & Abb.)

1957 **656** .212 .5 (73)
Die Bundesbahn, Nr. 21, November, S. 1650.
Markham — ein **amerikanischer Rangierbahnhof** nahe Chicago. (1 500 Wörter & Abb.)

1957 **621** .139 (43), **625** .18 (43 & **625** .27 (43)
Die Bundesbahn, Nr. 22, November, S. 1666 und 1673.
JESSEN (H.). — **Stoffwirtschaft mit Alt- und Abfallstoffen.** (4 000 Wörter & Abb.)
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1957 **625** .18 (43)
Die Bundesbahn, Nr. 22, November, S. 1684.
HARREUTHER (H.). — **Altstoffwirtschaft im Oberbau.** (5 000 Wörter & Tafeln.)

Deutsche Eisenbahntechnik. (Berlin.)

1957 **656** .221
Deutsche Eisenbahntechnik, November, S. 489.
Berechnung des Fahrwiderstandes bei hoher Geschwindigkeit. (2 000 Wörter, Tabellen & Abb.)

1957 **625** .215
Deutsche Eisenbahntechnik, November, S. 493.
DÜCK (W.). — Die Entwicklung von Formeln und Rechenhilfsmittel für die **Berechnung der Drehgestellausschläge.** (4 000 Wörter, Tabellen & Abb.)

1957 **625** .23
Deutsche Eisenbahntechnik, November, S. 501.
MÜSSIG (W.). — **Fünfteiliger Doppelstock-Gliederzug.** (3 000 Wörter & Abb.)

1957 **625** .245
Deutsche Eisenbahntechnik, November, S. 506.
SCHILLER (K.). — Schienenfahrzeuge für **Zementtransport.** (1 500 Wörter & Abb.)

1957 **621** .132 .8
Deutsche Eisenbahntechnik, November, S. 509.
SCHULZE (H.) & SCHWERIN (C.). — Was ist aus der **Franco-Lokomotive** geworden ? (4 000 Wörter & Abb.)

1957 **621** .135 (01
Deutsche Eisenbahntechnik, November, S. 517.
WIRTH (W.). — **Gewichtsausgleich und Wägeeinrichtung für Triebfahrzeuge.** (2 000 Wörter & Abb.)

1957 **656**
Deutsche Eisenbahntechnik, November, S. 521.
DIETZE (R.). — **Vergleich der Kosten direkter Eisenbahntransporte** mit denen gebrochener Eisenbahn-Binnenschiffstransporte. (6 000 Wörter & Tabellen.)

1957 **625** .42 (47)
Deutsche Eisenbahntechnik, November, S. 534.
Der technische Fortschritt im **Untergrundbahnbau der Moskauer Metro.** (1 200 Wörter & Abb.)

Der Eisenbahningenieur. (Frankfurt am Main.)

1957 **625** .251
Der Eisenbahningenieur, November, S. 303.
SCHÖNING (P.). — **Näherungsgleichungen für Bremswege** von Eisenbahnfahrzeugen und ihre Genauigkeit. (3 000 Wörter, Tabellen & Abb.)

1957 **621** .138 .3
Der Eisenbahningenieur, November, S. 308 und. 310.
ROOS (T.). — **Mechanisierung der Triebfahrzeugreinigung.** (1 500 Wörter & Abb.)
GUSINDE (H.). — Betriebliche Forderungen an die **Triebfahrzeugreinigung.** (1 000 Wörter & Abb.)

1957 **625** .26 (43) & **725** .33 (43)
Der Eisenbahningenieur, November, S. 312.
RIEDL (J.). — **Bau und Unterhaltung der Bundesbahn-Ausbesserungswerke.** (800 Wörter & Abb.)

1957 **625** .113
Die Eisenbahningenieur, November, S. 313.
HENN (W.). — **Verfeinerung des Richtverfahrens** für Gleisbogen. (1 000 Wörter.)

E.T.R. - Eisenbahntechnische Rundschau. (Köln-Darmstadt.)

1957 **625** .215 (43)
Eisenbahntechnische Rundschau, November, S. 407.
LIPPL (E.). — Die **Entwicklung des Drehgestells der Bauart « München-Kassel »**. (7 000 Wörter & Abb.)

1957 **624** .6
Eisenbahntechnische Rundschau, November, S. 422.
ERDMANN (W.). — Erneuerung der **Abdichtung einer Dreigelenkbogenbrücke.** (3 500 Wörter & Abb.)

1957 **621** .431 .72 (43)
Eisenbahntechnische Rundschau, November, S. 430.
FRIEDRICH (K.) & SEIDEL (M.). — Die **Diesellokomotive V 200** der Deutschen Bundesbahn als Serienausführung. (5 000 Wörter, Tafeln & Abb.)

Elektrische Bahnen. (München.)

1957 **621** .33 (52)
Elektrische Bahnen, Heft 11, S. 241.
SEKI (Sh.). — Die **Elektrisierung** der Japanischen Staatsbahnen mit Einphasenwechselstrom (50 und 60 Hz.) (2 000 Wörter, Tabellen & Abb.)

1957 **625** .215
Elektrische Bahnen, Heft 11, S. 247.
KUREK (E.-G.) & von BISMARCK (G.). — **Zur Frage der Querkräfte übertragenden Kupplung von Drehgestellen.** (2 000 Wörter, Tabellen & Abb.)

1957 **621** .336
Elektrische Bahnen, Heft 11, S. 254.
BÜCKNER (W.). — Mechanische Probleme der **Stromübertragung zwischen Fahrleitung und Stromabnehmer** elektrischer Bahnen. (3 000 Wörter & Abb.)

Elektrotechnik und Maschinenbau. (Wien.)

1957 **621** .31
Elektrotechnik und Maschinenbau, 1. Dezember, S. 523.
FRANKEN (H.). — Die **Eichung von Motorschutzgeräten.** (3 000 Wörter & Abb.)

1957 **621** .31
Elektrotechnik und Maschinenbau, 1. Dezember, S. 529.
CHRISTL (H.). — **Streuungsberechnungen mit Hilfe der magnetischen Energie an Transformatoren.** (2 000 Wörter & Abb.)

1957 **621** .31
Elektrotechnik und Maschinenbau, 15. Dezember, S. 551.
KADE (F.). — Der **Induktionsmotor mit Doppelkäfigläufer.** (3 000 Wörter & Abb.)

E.T.Z. (Elektrotechnische Zeitschrift.). (Berlin.)

1957 **621** .333
E.T.Z., 11. Dezember, S. 893.
KOTHER (H.). — **Bemessung von Bahnmotoren.** (1 000 Wörter, Tafeln & Abb.)

1957 **621** .35
E.T.Z., 21. Dezember, S. 487.
EULER (J.). — **Plattenbatterien für hohe Spannungen und ihre Verwendung.** (1 500 Wörter & Abb.)

1957 **621** .31
E.T.Z., 21. Dezember, S. 491.
NEUNTEUFEL (A.). — **Hydrophobe Porzellanisolatoren.** (1 000 Wörter & Abb.)

Glasers Annalen. (Berlin.)

1957 **621** .431 .72
Glasers Annalen, November, S. 379 und Dezember, S. 425.
GERLACH (W.). — **Die Drehfederzahl gummielastischer Kupplungen im Primärsystem dieselhydraulischer Lokomotiven.** (17 000 Wörter, Tafeln & Abb.)

1957 **656** .1 & **656** .2
Glasers Annalen, November, S. 389 und Dezember, S. 419.
MASEL (S.). — **Die Entwicklung des Huckepack-Verkehrs.** (12 000 Wörter, Tafel & Abb.)

1957 **621** .431 .72
Glasers Annalen, November, S. 395.
KREGLEWSKI (A.). — **Der direkte Antrieb von Brennkraftlokomotiven, insbesondere von Gaslokomotiven.** (9 000 Wörter, Tafeln & Abb.)

1957 **621** .431 .72 (45)
Glasers Annalen, November, S. 400.
MESSERSCHMIDT (W.). — **Neue italienische Diesellokomotiven.** (1 200 Wörter & Abb.)

1957 **625** .3
Glasers Annalen, Dezember, S. 409.
MARQUARD (E.). — **Kurvenführung und Querfederung der Balkenbahn.** (6 000 Wörter & Abb.)

Internationales Archiv für Verkehrswesen. (Mainz.)

1957 **385** .517 (494)
Int. Archiv. für Verkehrswesen, Nr. 22, 2. Novemberheft, S. 511.
RINGLEB (W.). — Die **Altersversorgung des Personals der Schweizerischen Bundesbahnen** im Lichte der deutschen Problematik. (1 500 Wörter.)

1957 **625** .142
Int. Archiv. für Verkehrswesen, Nr. 24, 2. Dezemberheft, S. 553.
BÄSELER (W.). — Die **Unterschwellung des Eisenbahngleises** als Tragfläche und Klammer. (2 000 Wörter.)

Der Öffentliche Verkehr. (Bern.)

1958 **625** .6 (494)
Der öffentliche Verkehr, Januar, S. 3.
Die Privatbahnen und das Jahr 1957. (1 700 Wörter.)

Schweizerisches Archiv für Verkehrswissenschaft und Verkehrspolitik. (Zürich.)

1957 **656**
Schweizerisches Archiv für Verkehrswissenschaft und Verkehrspolitik, Nr. 4, S. 287.
NAPP-ZINN (A.F.). — **Prinzipien der Verkehrspolitik.** (4 000 Wörter.)

1957 **385** (489)
Schweizerisches Archiv für Verkehrswissenschaft und Verkehrspolitik, Nr. 4, S. 323.
PASZKOWSKI (F.). — Die **Eisenbahnpolitik Dänemarks.** (10 000 Wörter & Karte.)

Signal und Draht. (Frankfurt-Main.)

1957 **656** .251
Signal und Draht, Dezember, S. 175.
SCHMITZ (W.). — Über die Entwicklung eines **internationalen Signalsystems.** (3 000 Wörter & Abb.)

1957 **656** .254
Signal und Draht, Dezember, S. 180.
LEINER (G.). — **Leichtere Bespulung von Fernmeldekabeln** der Deutschen Bundesbahn. (1 500 Wörter, Tabellen & Abb.)

1957 **656** .257
Signal und Draht, Dezember, S. 183.
STEINFELD (H.). — **Prüfen von Spurplanstellwerken.** (2 000 Wörter, Tabellen & Abb.)

Verkehr. (Wien.)

1958 **656** .23 (73)
Verkehr, 11 Jänner, S. 41.
LOWE (G.E.). — **Eigenheiten des Amerikanischen Tarifwesens.** (800 Wörter & Karte.)

In English.

Association of American Railroads. (Chicago.)

1957 **385** (061 .4 (73)
Proceedings, Association of American Railroads, Signal Section, Vol. LIV, No. 2.
Minutes Fifty-eighth Annual Meeting, Chicago, Ill., September 1920 and 21, 1957 (123 pages, illustrated.)

Bulletin-American Railway Engineering Association. (Chicago.)

1957 **385** (061 .4 (73)
Bulletin-American Railway Engineering Association, Vol. 59, No. 539, November, p. 391.
Reports of Committees : Economics of railway location and operation: Highways; Water, Oil and Sanitation Services; Contract forms; Yards and Terminals; Buildings; Waterways and Harbors. (164 pages, illustrated.)

The Engineer. (London.)

1957 **621** .335 (54)
The Engineer, Dec. 6, p. 830.
3 120 HP electric locomotive for Indian Railways. (2 400 words & figs.)

1957 **656** .25 (42)
The Engineer, Dec. 13, p. 870.
Programme machine for Northern Line signalling. (200 words & figs.)

1958 **625** .28 (42)
The Engineer, Jan. 3, p. 30.
British Railways. (1 500 words.)

1958 **656** .25 (42)
The Engineer, Jan. 17, p. 96.
Automatic signalling on the northern line. (2 200 words & figs.)

Proceedings, The Institution of Civil Engineers. (London.)

1958 **625** (42)
Proceedings, The Institution of Civil Engineers, January, p. 9.
VINER-BRADY (N.E.) and PEARSON (H. MacG.). — **Use of aerial photography by railways.** (14 pages, illustrated.)

The Proceedings of the Institution of Electrical Engineers. (London.)

1957 **621** .335
The Proceedings of the Institution of Electrical Engineers, October, p. 341.
CALVERLEY (H.B.), JARVIS (E.A.K.) and WILLIAMS (E.). — **Electrical equipment for rectifier locomotives.** (14 pages with figs.)

1957 **621** .335
The Proceedings of the Institution of Electrical Engineers, October, p. 355.
CALVERLEY (T.E.) and TAYLOR (D.G.). — **Circuit calculation for rectifier locomotives and motor-coaches.** (17 pages with figs).

1957 **621** .33
The Proceedings of the Institution of Electrical Engineers, October, p. 376.
Discussion on « The potentialities of railway electrification at the standard frequency ». (7 pages.)

1957 **621** .331
The Proceedings of the Institution of Electrical Engineers, October, p. 383.
HUMPHRIES (J.D.). — **Earth-electrode systems for large electric stations.** (17 pages with figs.)

Journal, The Institution of Locomotive Engineers. (London.)

1957 **621** .133 .7
Journal, The Institution of Locomotive Engineers, Vol. 47, Part No. 3, p. 229.
PARSONS (A.G.). — **Some aspects of locomotive boiler feed water treatment.** (22 pages, illustrated.)

1957 **621** .133 .7 (42)
Journal, The Institution of Locomotive Engineers, Vol. 47, Part No. 3, p. 251.
HANCOCK (J.S.). — **A brief history of locomotive feed water treatment on the London Midland Region of British Railways.** (43 pages, illustrated.)

1957 **625** .24
Journal, The Institution of Locomotive Engineers, Vol. 47, Part No. 3, p. 294.
CAMPBELL (A.). — **Unification of freight vehicles on Oversea Railways.** (38 pages, illustrated.)

The Locomotive. (London.)

1957 **621** .431 .72 (42)
The Locomotive, Nov.-Dec., p. 213.
Diesel-electric multiple units on the Southern Region. (1 600 words & figs.)

1957 **621** .431 .72 (42)
The Locomotive, Nov.-Dec., p. 222.
Brush 1 250 HP Diesel-electric locomotive for British Railways. (800 words & figs.)

1957 **621** .431 .72 (42)
The Locomotive, Nov.-Dec., p. 225.
B.T.H. 800 HP Diesel-electric locomotives for British Railways. (800 words & figs.)

1958 **621** .33 (42)
The Locomotive, Jan., p. 1.
The Kent coast electrification of British Railways. (600 words & figs.)

Modern Transport. (London.)

1957 **625** .4
Modern Transport, December 7, p. 5; Dec. 28, p. 13.
MAXWELL (F.G.). — **Underground railways in North West Europe.** (*concluded*) (2 200 words.)

1957 **621** .33 (42)
Modern Transport, Dec. 14, p. 3.
Putting up the wires. (1 200 words & figs.)

1957 **625** .285 (45)
Modern Transport, Dec. 14, p. 11.
Italian Trans-Europ-Express units. (1 600 words & figs.)

1957 **656** .212 .5 (42)
Modern Transport, Dec. 28, p. 5.
New marshalling yard at Thornton. (1 800 words & figs.)

Railway Age. (New York.)

1957 **656** .212 (73)
Railway Age, October 21, p. 26.
Newest yard is built to grow with traffic. (700 words & figs.)

1957 **656** .212 .8 (73)
Railway Age, Nov. 11, p. 29.
Car weights by the train load. (600 words & figs.)

1957 **656** .212 (73)
Railway Age, Nov. 18, p. 14.
The Wabash centralizes. **New yard speeds Chicago service.** (1 600 words & figs.)

1957 **625** .171 (73)
Railway Age, November 25, p. 20.
Wayside detectors enhance safety. (1 800 words & figs.)

1957 **656** .225 (73)
Railway Age, Dec. 16, p. 14.
« Pat » - **A fresh approach to piggyback and container problems.** (300 words & figs.)

1957 **621** .338 (8)
Railway Age, Dec. 16, p. 29.
New M.U. electric cars in Brazil. (800 words & figs.)

Railway Engineering. (Cape Town.)

1957 **625** .214 (68)
Railway Engineering, Nov., p. 28.
ÖVERGAARD (B.). — **Recent roller bearing designs for S.A.R. locomotives and electric motor coaches.** (1 500 words & figs.)

1957 **621** .431 .72 (6)
Railway Engineering, Dec., p. 20.
Diesel-electric locomotives recommended for main line service in East Africa. (1.500 words.)

1957 **621** .431 .72
Railway Engineering, Dec., p. 31.
Rolls-Royce diesel railcar engine test bed simulates actual operating conditions. (1 000 words & figs.)

The Railway Gazette. (London.)

1957 **625** .1 (42)
The Railway Gazette, November 8, p. 546.
Pre-electrification works in the Eastern Region. (300 words.)

1957 **656** .224
The Railway Gazette, Nov. 15, p. 557.
Passenger comfort. (400 words.)

1957 **656** .2 (68)
The Railway Gazette, November, p. 561.
du PLESSIS (D.H.C.). — **Progress of the South African Railways.** (2 400 words & figs.)

1957 **625** .13
The Railway Gazette, Nov., p. 565.
Rail-mounted viaduct inspection unit. (600 words & figs.)

1957 **621** .431 .72
The Railway Gazette, Nov., p. 567.
Railcar Diesel power equipment test bed. (1 000 words & figs.)

1957 **621** .431 .72 (42)
The Railway Gazette, Nov. 22, p. 590.
Type «I» Diesel-electric locomotive for British Railways. (1 300 words & figs.)

1957 **656** .25 (42)
The Railway Gazette, Nov. 22, p. 592.
Rail circuits without insulated joints. (600 words & figs.)

1957 **621** .335 (42)
The Railway Gazette, Nov. 22, p. 597.
Rectifier locomotives in Japan. (900 words & figs.)

1957 **656** .212 (42)
The Railway Gazette, Nov. 29, p. 622.
Planning a freight transfer. (1 200 words.)

1957 **656** .25 (6)
The Railway Gazette, Nov., p. 624.
Signalling developments in East Africa. (1 800 words & figs.)

1957 **625** .144 .4 (42)
The Railway Gazette, Dec. 6, p. 652.
Laying long welded rails in the N.E. Region. (400 words & fig.)

1957 **625** .214
The Railway Gazette, Dec. 6, p. 655; Dec. 20, p. 707.
Developments in spherical roller bearing axleboxes. 1-2. (1 900 words & figs.)

Diesel Railway Traction. (London.)

1957 **621** .431 .72 (47)
Diesel Railway Traction, November, p. 417.
Shunting locomotives for the U.S.S.R. (1 200 words & figs.)

1957 **621** .431 .72 (42)
Diesel Railway Traction, November, p. 420.
Two-car Diesel sets for British Railways. (800 words & figs.)

1957 **621** .431 .72 (54)
Diesel Railway Traction, November, p. 423.
Large locomotives for India. (1 400 words & figs.)

1957 **621** .138 .5 (41)
Diesel Railway Traction, November, p. 428.
Servicing and maintenance at Inchicore. (800 words & figs.)

1957 **621** .436 (437)
Diesel Railway Traction, November, p. 431.
ZAPLETAL (M.) and TRNKA (J.). — **Railway oil engines in Czechoslovakia.** (1 700 words & figs.)

1957 **625** .214
Diesel Railway Traction, November, p. 437.
Roller-bearing axlebox development. (800 words & figs.)

Railway Locomotives and Cars. (New York.)

1957 **621** .431 .72 (73)
Railway Locomotives and Cars, November, p. 54.
BORGARDUS (R.L.) and MURPHY (T.H.). — **Old locomotives can be made better than when new.** (1 400 words & figs.)

1957 **625** .243 (73)
Railway Locomotives and Cars, December, p. 32.
Pensylvania installs... first all-welded aluminium box car doors. (800 words & figs.)

1957 625 .215 (73)
Railway Locomotives and Cars, December, p. 34.
Transit cars have « air ride » trucks. (900 words & figs.)

Railway Magazine. (London.)

1958 621 .431 .72 (42)
Railway Magazine, January, p. 17.
New Diesel-electric locomotives for British Railways. (1 000 words & figs.)

Railway Track and Structures. (Chicago.)

1957 625 .13 (73)
Railway Track and Structures, November, p. 21.
Pipe templates... solve this tough bridge-rebuilding job. (1 600 words & figs.)

1957 656 .212 .8 (73)
Railway Track and Structures, December, p. 32.
Taking the wait out of weighing. (700 words & figs.)

In Spanish.

Ferrocarriles y Tranvias. (Madrid.)

1956 625 .143 .4
Ferrocarriles y Tranvias, Vol. 24-III, nº 271, p. 58.
BALBAS (A.). — **Soldadura de carriles.** (3 000 palabras & fig.)

1956 625 .285 (460)
Ferrocarriles y Tranvias, Vol. 24-IV, nº 272, p. 88.
SPINEDY (E.S.). — **Las locomotoras Diesel-eléctricas ALCO numeros 1 601 - 1 617, de la RENFE.** (5 000 palabras & fig.)

1956 625 .113
Ferrocarriles y Tranvias, Vol. 24-IV, nº 272, p. 98.
ALIX (L.). — El **peralte en las curvas de los ferrocarriles.** (1 200 palabras.)

Transportes. (Madrid.)

1957 625 .3
Transportes, nº 61, noviembre-diciembre, p. 252.
NORTHON (L.). — **Perspectivas del monorail** como moderno sistema de transporte. (1 200 palabras & fig.)

In Italian.

Alluminio. (Milano.)

1957 621 .31 (45)
Alluminio, nº 12, dicembre, p. 536.
Orientamenti attuali sull' **impiego dei conduttori di alluminio** in Italia nelle linee aere per il trasporto di energia. (3 000 parole & fig.)

Ingegneria Ferroviaria. (Roma.)

1957 656 .2
Ingegneria Ferroviaria, novembre, p. 899.
RISSONE (S.). — Le **prospettive del trasporto su rotaia.** (6 000 parole & tabelle.)

1957 656 .257
Ingegneria Ferroviaria, novembre, p. 909.
TOLOTTI (F.). — I **moderni indirizzi nella tecnica degli apparati centrali** e il nuovo sistema a pulsanti delle F.S. (9 000 parole & fig.)

1957 625. 111
Ingegneria Ferroviaria, novembre, p. 925.
CORRENTI (V.). — Nomogrammi a curve ausiliarie per il **calcolo delle sezioni nei tracciati ferroviari.** (1 500 parole, tavole & fig.)

1957 625 .244
Ingegneria Ferrovaria, novembre, p. 931.
RHO (P.) & TROTTA (G.). — **Lo sviluppo dei trasporti ferroviari in regime di freddo** e il potenziamento del parco dei carri refrigeranti. (8 000 parole & tabelle.)

La Ricerca Scientifica. (Roma.)

1957 656 .254
La Ricerca scientifica, novembre, p. 3241.
MARINO (A.). — Evoluzione stato attuale e tendenze dei **sistemi elettrici di trasmissione delle informazioni a distanza.** (3 000 parole.)

Rivista di Ingegneria. (Milano.)

1957 621 .3
Rivista di Ingegneria, dicembre, p. 1381.
MASSA (E.). — **L'assorbitore dinamico non lineare non smorzato con vincolo elastico di rigidezza costante a tratti** *(Continuazzione)*. (5 000 parole & fig.)

Trasporti Pubblici. (Roma.)

1957 621 .335 (47)
Trasporti Pubblici, settembre, p. 1199.
Locomotori elettrici sovietici a 50 Hz. (2 000 parole & fig.)

In Netherlands.

Spoor- en Tramwegen. (Den Haag.)

1957 656 .212
Spoor- en Tramwegen, nr 26, 19 december, p. 410.
Geeft « palletization » besparing? (800 woorden.)

1957 656 .23 (73)
Spoor- en Tramwegen, nr 26, 19 december, p. 411.
Tarifstelling bij Amerikaanse spoorwegen. (2 000 woorden.)

1958 **385** .113 (492)
Spoor- en Tramwegen, nr 1, 2 januari, p. 2.
De N.V. Nederlandsche Spoorwegen in 1957. (4 500 woorden & fig.)

1958 **621** .13 (492)
Spoor- en Tramwegen, nr 2, 16 januari, p. 19.
QUANJER (J.) en de PATER (A.D.). — **De ontwikkeling van de stoomlocomotief in Nederland.** (3 500 woorden & fig.)

1958 **625** .28 (492)
Spoor- en Tramwegen, nr 2, 16 januari, p. 25.
VAN ALBADA (N.B.). — **De technisch-economische redenen van het verdwijnen van de stoomlocomotief.** (5 000 woorden & fig.)

1958 **385** .574
Spoor- en Tramwegen, nr 2, 16 januari, p. 30.
MANSVELT BECK (F.B.). — Het **krachtvoertuig-personeel in de branding.** (2 000 woorden.)

1958 **621**.137
Spoor- en Tramwegen, nr 2, 16 januari, p. 33.
KARSKENS (J.J.). — **Locomotieven met een naam.** (1 000 woorden & fig.)

In Portuguese.

Gazeta dos Caminhos de Ferro. (Lisboa.)

1957 **385** .114
Gazeta dos Caminhos de Ferro, nº 1681, 1 Janeiro, p. 5.
FARIO LAPA (J.). — A medida dos **efeitos da variaçáo do preço di transporte sobre o rendimiento da empresa transportadora.** (1 700 palavras.)

1957-58 **385** (09 (469)
Gazeta dos Caminhos de Ferro, nº 1682, 16 de Janeiro, p. 9.
MANITTO TORRES (C.). — A **evoluçáo dás linhas portuguesas** e o se ignificado ferroviário. *(Continua.)* (6 000 palavras.)

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